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Irrigation

WORLD CROPS

Agricultural Chemicals, Farm Supplies and Machinery

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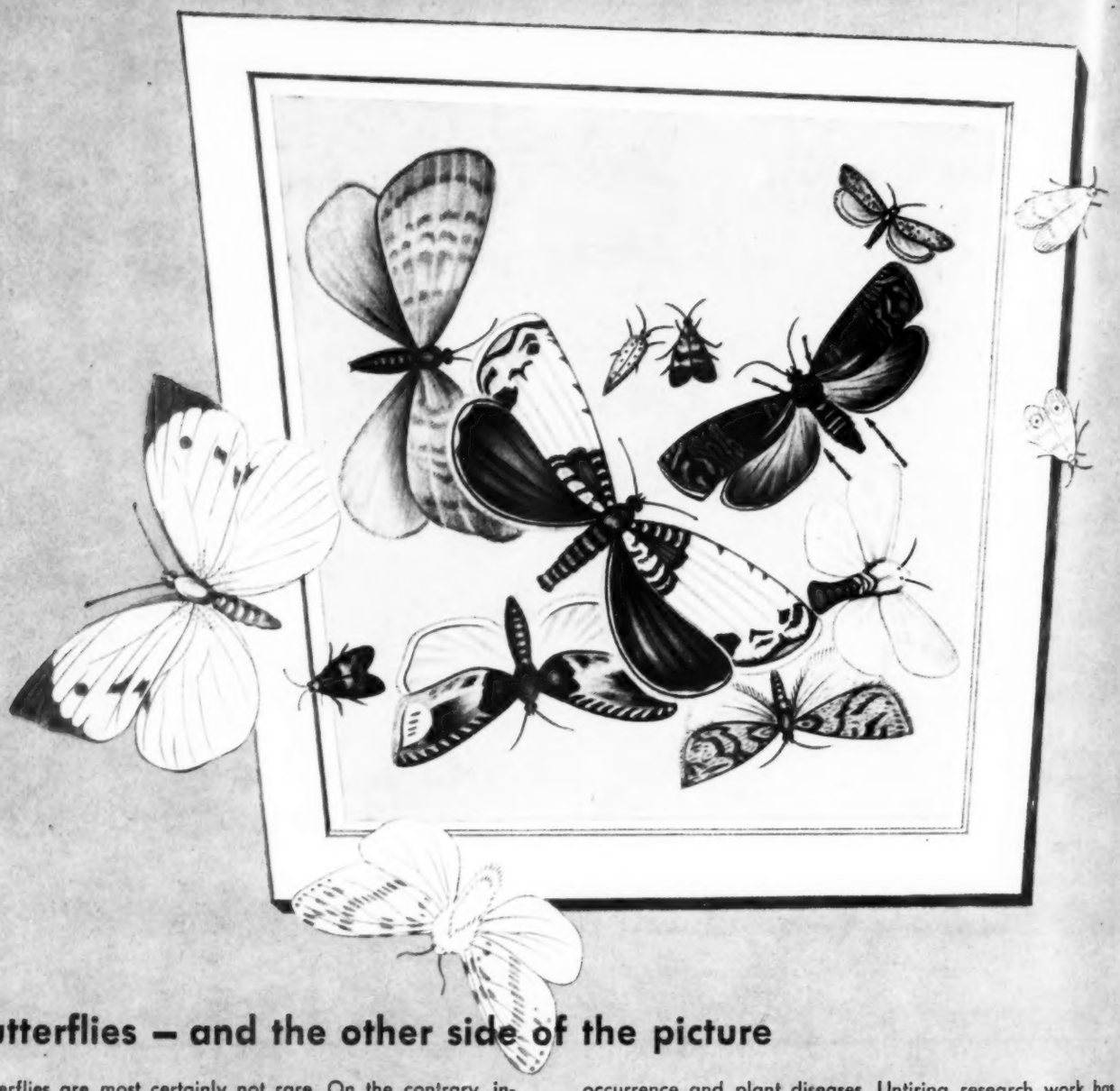
Photo: Borax Consolidated Limited

'Heart Rot' of sugar-beet due to severe boron deficiency. Such crop losses can be prevented by the application of boron to the soil. Further details on page 126.



Butterflies – and the other side of the picture

Butterflies are most certainly not rare. On the contrary, innumerable varieties are to be found all over the world in places where valuable crops are grown. The man in the street is amused by the way they flutter about, but to the farmer they are a thorn in the side. Agriculturists are only too well aware of their inconceivable powers of reproduction, and know better than most that their voracious caterpillars are capable of occurring in such huge numbers as to destroy overnight all hopes of reaping a good harvest in wide farming regions.

It is only a few decades ago that man had to look on, almost helpless, as pests devastated his fields and plantations. What could he do against this "power"? Carefully planned crop protection, made possible by the progressive development of modern pesticides, brought about by the exhaustive and incessant research work of the chemical industry, provided the answer, and today enables serious catastrophes caused by insect pests to be prevented.

For fifty years past, Farbenfabriken Bayer have been constantly engaged on the task – and with growing success – of helping agriculturists in all parts of the world to overcome their difficulties, and to minimize the hazards of insect pest occurrence and plant diseases. Untiring research work has led to the discovery of now world-famous products which are used in all regions where valuable crops are cultivated.

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Editorial Comment

Water the Key?

OWING TO the concentration of populations in certain areas and the steady growth of these populations water is a more important factor in problems of world populations than is generally realised. Surplus food can be moved from country to country, but surplus water is not so easy to obtain and distribute.

We can recall the troubles between California and Nevada over the water supplies from the Colorado river, between India and Pakistan over the waters of the Indus, and in East Anglia – the driest part of Britain – there is constant dispute over riparian rights as between the agricultural community and the industrial and domestic consumers.

The fertile Po valley of Italy now needs more water – not merely for irrigation, but to meet the needs of its growing industries, the seasonal demands of the tourist industry and, of course, the domestic needs of the rapidly increasing population. On page 133 Douglas Wood describes the steps which need to be taken to find fresh sources of this essential commodity. It is, in effect, the key to the future of this region.

Thus, although the world's reserves of fresh water might appear to be inexhaustible, water can, in fact, become a real cause for dispute between nations. That is why irrigation schemes now being developed in all parts of the world and the hydrological studies now being carried out in Australia, Israel and other arid regions are of such vital importance to the peace of the world, the problem being to use the available supplies usefully before they are either lost underground, are evaporated or pass down the rivers to the sea.

Failing Supplies of Water

ONE ASPECT of the problem is the decline in the yields of existing wells or – as in Jaffna, Ceylon – the increasing salinity of existing wells when a water table is drawn on excessively through the population increasing in excess of the water supplies. Where water extraction takes place through hundreds of wells the integrated effect is similar to that of over-pumping a single well.

Sometimes in drought periods wells can be so drawn on that the particles seal the flow-lines. The failure of such wells may stem from mechanical causes. Thus, as the sand and fine particles of clay are extracted, the clay roof of an aquifer tends to collapse and choke the flow to the borehole. Alternatively, the annular space between the liner and the water-bearing strata may become choked with clay. Another possible source of trouble is limestone in solution in the waters of the aquifers. When the slots in the liners and screens become encrusted with deposits of limestone they act as barriers to the flow of water into the well.

Water for Better Crops

WHILE THE value of irrigation for surface-rooting crops has been amply proved by the work done at the National Vegetable Research Station and by the field experiments carried out by the manufacturers of rain-guns and spraylines, the need for water by perennial tree crops is not properly appreciated in Britain, although in the U.S.A. the irrigation of citrus orchards is an established practice (see WORLD CROPS, 1959, 11, 217).

Some 40 years ago the late W. W. Wardlaw, a Malayan planter, who was also a civil engineer, installed a two-way irrigation and drainage system on a 1,000-acre coconut estate, drawing his water from the Krian Irrigation Scheme. The water was taken from the main canal and introduced into a closed system of ditches between alternate rows of palms, forming the irrigation grid, and a similar opposing grid served for drainage, the outgoing water from each ditch being collected in a main drain until it could be released at low tide by outfall to the sea.

Perhaps the most remarkable feature about this irrigation/drainage system was the fact that the estate had to be surrounded by an immense earth bund or sea wall, since at high tide this alluvial flat – a former mangrove swamp – was well below sea level. The quick release of the drainage waters was effected by opening four screw gates arranged at intervals in the sea wall. Another complicating factor was the possibility of flooding due to heavy tropical downpours of from 1 in. to 4 in. in an hour, the average annual rainfall being between 50 in. and 60 in.

By careful management of the incoming and outgoing waters a head of between 18 in. and 2 ft. was normally maintained. The value of this system of controlled irrigation was shown by the fact that this was the highest-yielding coconut estate in the country, in spite of no fertilisers being used.

Water for Orchard Crops

ORCHARDS IN Britain, where in places the rainfall can be as little as 20 in. a year and where one summer in four has a period of drought, are not usually basin, furrow or ditch irrigated, nor are spraylines or rain-guns generally used. Yet it is certain that the condition of the trees would improve and better crops would be obtained by water applied at the right time and in the right amount.

According to Mr. J. E. Goode, of the East Malling

Research Station, fruit trees are able to draw on a larger volume of soil for their water than surface crops, but once the root zone is depleted by a drought the damage can be much greater, particularly where the land is excessively drained or the soil is of low moisture-holding capacity. Little work has been done on this subject hitherto, because a fruit tree is slow to show the effects of water deficiency.

Conversely, fruit trees are slow to show the effects of applied water and during the first four years irrigation costs are barely covered, but after that the difference between the watered trees and the unwatered controls is most marked and the returns greatly exceed the cost of watering.

It is probably this delayed action effect which has prevented the wider use of irrigation in the orchards of Britain and the results of Mr. Goode's experiments are so promising as to justify large-scale experiments on a statistical footing in a number of commercial orchards.

Pluck Me a Tea Bush

DURING HIS recent visit to Africa Mr. Leonard Hill stayed in the tea areas of Kenya and reported to us that ' a well-plucked estate with rows and rows of bushes absolutely level is a very pleasing sight '.

Yet what a complex problem the fixing of the correct height of the plucking table presents. The large-leaved type of plant, the Assam variety, has been grown on estates in many countries for over a hundred years, but details of the plucking process are still subjects for trial and argument. Indeed, it was one of the main topics dealt with at the Annual Conference held at the Tocklai Research Institute last November.

The problem is how best to turn the 2-year sapling of a tree, normally 30 ft. high, into a bush about 3 ft. high x 4 ft. across, the top foliage of which can be hand plucked by a man or woman walking round it. Both pruning and plucking can stimulate the bush to produce more leaf, although both processes, too harshly or too lightly applied, will lose crop.

To get the maximum out-turn it is essential to correlate the ' tipping ' or first plucking height with the pruning. Then the ultimate plucking level must be related to the tipping, and even this may perhaps be modified later to fit in with the next pruning round – one, two or even five years hence. Where the Assam variety is grown a flat plucking table is preferred, but with the China variety an oval table is often developed.

Bushes are generally plucked weekly in the season and the standard aimed at is two leaves and a bud. Five pluckers are needed to deal with an acre of high-yielding tea in a day, and each can bring in about 60 lb. of fresh leaf. An estate of 1,000 acres, plucked on a seven-day round, needs about 835 active pluckers per day, working a six-day week. This operation presents a tea estate with its main labour problem.

Over 50 years ago the tea industry in Japan met high plucking costs by using light shears fitted with a scoop on one blade to push the cut leaf into a cotton bag fixed on the other. By this means the crop garnered per plucker rose from 30 lb. fine leaf to 300 lb. per day. The bushes in Japan are flush plucked only four or five times a year, when the whole flush up to five small leaves is taken.

Hand-operated machine pluckers, driven by small motors, have been tried in Assam, Ceylon and Africa, and also four-wheeled machines driven astride the rows. However, such machines cannot select only the ' ready ' leaf and leave on the bush the ' unready ' shoots. Little or no gain in total crop results and the general leaf standard is inferior to that hand plucked.

In Georgia, U.S.S.R., where the China variety is grown, efforts to pluck selectively with a machine have met with partial success. The machine spans the bushes and under the leaf cutter are flexible rubber projections which depress a proportion of the softer, younger, unready shoots and so allow them to escape the cutter. The cut leaf is drawn by suction upwards into a container above the cutter.

The leaf cropped in this way is still less even than that hand plucked, and only a very small acreage in Georgia is dealt with in this manner. The machine requires two operators, but it is capable of covering 12 acres per day.

It is likely that, in due course, most plantation tea will have to be mechanically plucked, and future plans for replanting need to take this prospect into consideration. The resulting level sheet of green tea bushes will still be a very pleasant sight, as Mr. Hill has observed.

Irrigation in the Tropics

WHERE RAINFALL is inadequate or erratic, it is the usual practice in the tropics to resort to flood, furrow, ditch, basin or terrace irrigation. Generally this results in over-watering, leading to severe leaching of soil nutrients and sometimes water is used so liberally that the wells either dry up, or the sub-soil waters become brackish and undrinkable.

Mr. Trevor Garbeth, who recently visited Ghana, Nigeria, East Africa, the Rhodesias and the Union of South Africa, told us that he was convinced that there are tremendous prospects for the increased production of food and economic crops and the opening up of new areas through irrigation in most of the territories he visited. The crops he particularly mentioned were wheat (which is replacing maize as a food crop in Africa), grass (perhaps the most important application), bananas, sugar cane and tobacco. Rice, too, can be grown under sprinklers in arid areas where flood irrigation is impossible.

In those places where water is inadequate for the agricultural, industrial and domestic needs of the people, controlled overhead irrigation, by rain lines or rain guns, was, he considered, absolutely essential,

if the best use was to be made of the limited supplies available, particularly where desert conditions are likely to spread, consequent on the growing shortage of water with the increase of population. The Kalahari desert, for instance, is spreading as the wells dry up.

Perhaps the most important points he made were that there is no idea of exactly how much water is required by various crops, when to apply the water and when not to apply it, what are the advantages of overhead irrigation over flood irrigation, and what improvement in the quality and quantity results. Here obviously is an important new field for research in the tropics.

High Jinks!

A SYMPOSIUM entitled 'Advances in the Chemical Analysis of Soils, Fertilisers and Plants' is to be held in London on 20–21 April. This meeting has been arranged by the Agriculture Group of the Society of Chemical Industry for the presentation and discussion of pre-printed papers of previously unpublished work under the chairmanship of Dr. A. H. Cornfield. Some 13 papers are to be presented by eminent scientists from the leading agricultural research stations of Britain. Enquiries concerning this symposium should be addressed to the Hon. Sec., Dr. P. W. Arnold, Rothamsted Experimental Station, Harpenden, Herts.

It occurred to us to look up the word 'symposium'. We have hitherto rather assumed that a symposium was a meeting or gathering arranged for the collection and exchange of opinions on various aspects of a subject, but apparently we have been seriously in error, for on referring to the Concise Oxford Dictionary we learned that a symposium was 'an ancient Greek after-dinner drinking party with music, dancers or conversation'. We decided to probe further into the matter, but Nuttall's Standard Dictionary gave an even worse account of a 'sim-*po*-ze-um', describing it as 'a drinking together'; 'a merry feast'; and a 'banquet with philosophic discussion'.

We have frequently reported that 'the symposium was well attended' and some of our readers may have observed that it probably deserved to be! Scientists are, after all, quite human people in spite of the impression created by the popular press.

Fruitfulness

THERE ARE many well-known instances of incompatibility between plants of the same genus and even between those which are varieties of one species, and it is a fact that there is much more to be learned about this subject. We would hardly go so far as to say, however, that the problems of pollen handling and pollination requirements of horticultural crops and related factors, associated with the set of fruit, are basic to plant-breeding technique.

Surely the science of genetics is basic, for with many crosses creating varieties of fruit trees in the world today these varieties are unbalanced in their cell conditions; in other words, the plants are triploids and cannot halve their chromosomes exactly at meiosis. Genetical influences play a large part in successful plant breeding and without applying this science the modern plant breeder is at a disadvantage.

Unfruitfulness

AS TO the causes of unfruitfulness, external factors are very varied and would seem to play a much larger part than is suggested in the article in our January issue. For instance, there are 'on and off' years in regard to many fruit trees not necessarily linked with the season, as has been shown by experiments with coffee in Tanganyika and coconuts in Ceylon.

Trees over-bear and exhaust themselves and begin a phase of biennial production. They recuperate and over-bear again until freakish weather either upsets them completely or brings them into a more normal state. See page 159 – Olives.

Seasonal influences, too, are very great and with frosts at the wrong time, cold winds or extreme heat, according to the crop involved, artificial pollination would have little effect, and the various modern means of pollination can only be of use in restricted circumstances. There is an outstanding example of its use where male branches of the date palm are placed among the female branches when they are flowering, a

'I did so want to show you our irrigation system'

practice without which the date crop would be much less in some regions.

In the main, we still depend on natural pollination by the aid of wind or insects to set the crops of fruit trees. There can be much interference with the insect pollinators if pesticides are used indiscriminately.

Reaction to Revolution

AN FAO MISSION to Poland in 1947, we recall, recommended fundamental changes in the economic system, including family ownership of farm land, abolition of controls to allow a free market, raising the ceiling for land ownership to 60 acres, reducing expenditure on defence and security to provide money for more productive efforts, and a reversal of the trend towards a centralised economy. It was also recommended that no independent local co-operative society should be forced to join a co-operative federation against the will of its members.

According to Dr. M. Ezekiel, head of the Economics Department of FAO, who recently visited the country, there has been a rapid expansion of production as a result of the readjustment of price policies to give greater incentive to production. When in 1956 farmers were allowed to withdraw from collective farming, a high proportion of them reverted to the system of private ownership and today collective farms only account for 1% of the area under cultivation.

Naturally, State farms are important mainly in regions which are not attractive for private ownership or are former large estates which are still being operated collectively by the workers previously employed by the landowners. The State farms now remaining seem to act in much the same way as a Department of Agriculture elsewhere, producing certified seed and improved breeding stock.

The system of ' Village Circles ' established under Mr. Gomulka's government has now been re-established as a means of bringing extension and other services to the individual farmer. These Circles also engage in the buying and operation of spraying machines and harvesting machines, as well as the production of building materials required by farmers, in much the same way as the agricultural syndicates in Britain.

According to Dr. Ezekiel: ' The system of obligatory deliveries of farm produce at low prices is being gradually modified and recently the Government announced that funds obtained from the lower prices than those now prevailing in the free market would be credited to the Village Circles from which the agricultural products were obtained for the purchase of farm equipment. Under this arrangement the village pays 25% of the cost (with credit facilities if necessary) and the rest is paid by Government out of the accumulated reserves.

Horrible Murder

NOT CONTENT with foisting the ugly word ' broiler ' on to the English language, the chicken people have excelled themselves with a fresh atrocity – ' agribusiness ' – coined to describe what is claimed to be a new technique of farming. We know nothing about this new technique; it may be the last word in farming, but that is beside the point. 'Agribusiness ' must certainly be the last word; let it be strangled at birth and cast away hurriedly as an unwanted thing before it has time to stick.

Another undesirable importation is the meaningless expression ' zero grazing ' whereby grass is harvested mechanically and brought to the cattle instead of the cattle being taken to the grass. What is wrong with ' mechanical grazing ' or ' mechanised grazing '?

The English language has the richest and most descriptive vocabulary of any language on earth. Why then, is it made to spawn these monsters, which confuse instead of describe and make a travesty of that noble accomplishment which distinguishes man from the beasts – speech? We do not claim that WORLD CROPS' prose is exemplary; we are only too conscious of its failings, but we do try to avoid the more glaring examples of what a current well-known musical show – ' My Fair Lady ' – aptly calls ' the cold-blooded murder of the English tongue ', a crime which regrettably is perpetrated so often by technical journals.

This Month's Cover Picture

Boron deficiency in sugar-beet is a familiar problem in many countries, especially where the soil is light or deficiency has been induced by excessive liming. The most common symptoms are development of multiple crowns following the death of the older leaves, blackening of leaf stalks, external girdling and internal rotting of the root. Crop losses both in weight and sugar content can be serious.

Boron deficiency in sugar-beet can usually be corrected by the application of a boronated fertiliser to the seedbed or foliar spraying with soluble boron after singling. This treatment restores the boron balance, resulting in improved yield, quality and sugar content.

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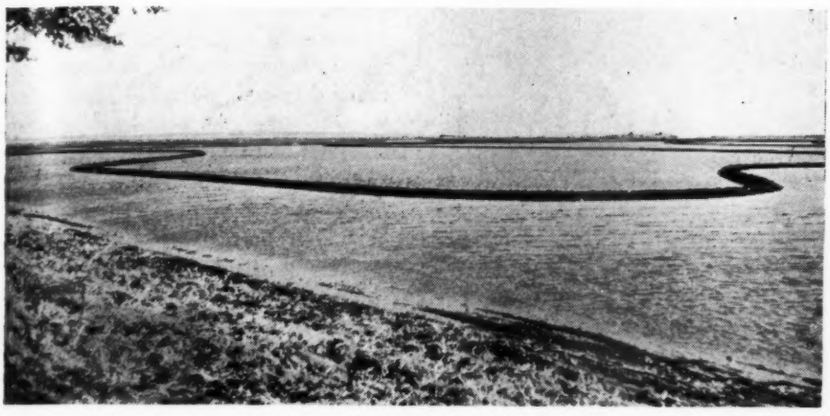
Irrigated Rice in California

P. B. VOSE, B.SC., N.D.A.*

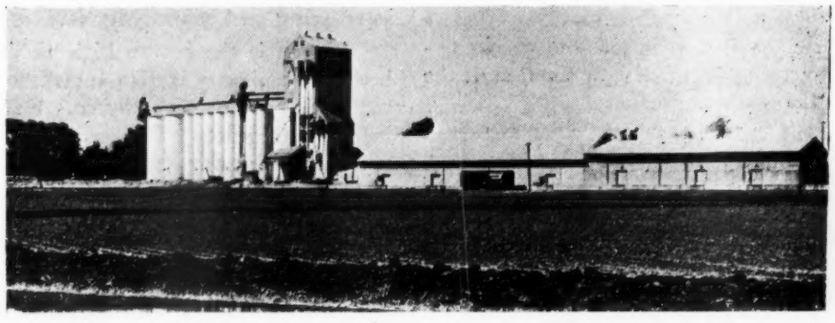


A recently flooded rice field in California, showing checks separated by temporary contour levees. A large flood embankment is seen in the foreground

Rice is grown in California under flood conditions in large, highly specialised and mechanised units. Pre-flooding, ammonium nitrogen fertilisation and aerial seeding after flooding are common practices.

RICE is grown in California in two regions. The main area is in the Sacramento Valley, particularly in the counties of Butte, Glenn and Colusa, and there is a secondary area in the San Joaquin Valley. From an acreage of 336,000 in 1955, acreage restrictions under the Soil Bank Programme have since brought the area down to about 230,000 acres. The crop is grown under flood conditions and the land is farmed in very large, highly specialised units.

The units are, highly specialised, in the sense that rice growing is by far the most important enterprise, all else being subsidiary. This specialisation is necessary because of the heavy capital expenditure involved in irrigation and drainage, in the purchase of combine harvesters and in the provision of rice mills and grain storage silos.



A rice-cleaning plant and grain elevator – a common sight in the rice area of the Sacramento Valley

Cultural conditions

Nearly all the rice soils are heavy, a high proportion of the rice fields in the Sacramento Valley area being of adobe clay, with a hard pan at varying depths. The annual rainfall here is about 20 in., precipitation being mostly in October, November and December, with no rain in the summer months. Temperatures during the critical growing months of June, July and August may frequently rise to over 100°F during the day and may often drop below 60°F at night.

Irrigation water in the Sacramento Valley area comes mainly from the Sacramento and Feather rivers, the canal distribution systems being managed by district irrigation boards and by mutual companies. About 10% of irrigation water is obtained from boreholes and pumps on individual farms, but this system is a handicap when the initial flooding is being carried out, due to the lack of an immediate head of water.

Much of the Sacramento Valley rice area is very flat and low-lying and is liable to severe flooding in the winter months. Ploughing is therefore seldom possible after the harvest, but is carried out in March or April, as soon as the land is dry enough. This is an advantage, since all winter weed growth is ploughed in. Green manure crops seem likely to become more popular and this practice also requires spring ploughing.

Land preparation

The land is divided up with permanent or semi-permanent levees,† which follow the contours at 0.3-ft. elevation intervals. The area of each 'check',‡ or area so enclosed, varies considerably and depends on the level of the land and on the head of water available. Thus the larger the head of water and the flatter the land, the greater the area of the check which can be effectively flooded. Checks may be as large as 50 acres, though they are usually much smaller.

A number of factors determine whether the levees are permanent or whether they have to be pulled down before cultivating. If the area of a

* Plant Physiologist, Welsh Plant Breeding Station, University College of Wales, Aberystwyth.

† Levee: dyke, bund or artificial river bank.

‡ Check: paddy.

Germinating rice seedlings greening the water – a typical scene in the rice fields of California. Note the permanent levee in the foreground

check is small, it is awkward to work large mechanised implements in the confined space. It is easier to remove the levee and remake it, particularly where only small levees are required. On the other hand, where the area of the check is large, or where a fairly substantial levee is necessary, it is more usual to have permanent levees. Weed control is helped by temporary levees, but the advantage of permanent levees is that the checks become more level with time and the borrow pits disappear.

The smaller levees, which are about 2 ft. high and 3 ft. wide at the base, are put up by a ' checker ', pulled by crawler tractor, after the soil has been cultivated and loosened. Larger levees, 6–10 ft. wide at the base, are constructed by bulldozer. Quite often a field may be bordered by substantial permanent levees with smaller levees forming the checks.

After ploughing, the land is worked up into a coarse seedbed by disking and dragging and local high spots may be cut and depressions filled by land plane or scraper.

Irrigation

The service or head ditch for the irrigation water is located at the highest part of the field and is fitted with cross gates to raise the head of water when required. The head ditch, which is substantially constructed and not usually lined, does not generally extend to cover the whole field, but the water is allowed to flow from check to check towards the lowest part of the field. At the bottom end or lower sides of the field, a drainage ditch leads off to the main district drains.

Wooden boxes, to serve as water gates, are placed in the levees between the checks to allow water to pass from one check to another. Large checks require several gates, and these are so sited that the whole area of the check can be drained thoroughly. Their exact location is a matter of experience, but it is convenient if they can be placed fairly near the side of the field. The boxes are provided with a number of flash boards so that the level of the water in the check may be adjusted.

Fertilising and manuring

Nitrogen is the key to high yields here; phosphorus is also sometimes required, but not generally so. Formerly nitrogenous fertilisers were applied to the dry seedbed or were distributed from the air following flooding and sowing. It has, however, been conclusively shown[1] that maximum rice yields are obtained where the ammonium fertiliser is drilled or disked into the dry seedbed at a depth of 2–4 in. and that a loss of nitrogen occurs if it is simply broadcast, either into the seedbed or following flooding.

The explanation is that if ammonium nitrogen is present in the thin oxidising layer of flooded soils it is changed to the nitrate form and leached to lower depths, where it is converted anaerobically to gaseous nitrogen, which escapes and is lost. If ammonium fertiliser is drilled, so that it is placed below the surface oxidising layer, then it remains unchanged and is available to the plant.

The fertilisers most commonly used now are ammonium sulphate, anhydrous ammonia (82% N), which is ammonia gas compressed to liquid form, and aqua ammonia (20% N), in which ammonia gas is absorbed in water.

When released in the soil anhydrous ammonia becomes gasified, while similarly aqua ammonia contains volatile ammonia, and precautions must be observed to avoid loss. The use of anhydrous ammonia and aqua ammonia therefore requires special techniques; these materials are transported in tank containers either by road or rail and application in the field is by special injector equipment. The handling of these two fertilisers is mostly carried out by specialist contractors. Ammonium fertilisers are applied shortly before flooding, preferably not more than a few days before, otherwise the ammonium nitrogen is changed to nitrate and so lost to the plants on flooding.

The amount of nitrogenous fertiliser used varies: 60 lb. nitrogen per acre, equivalent to 300 lb. ammonium sulphate, is a fair average dressing, but dressings may be as high as 80 lb. nitrogen or as low as 30–40 lb. It has been demonstrated[2] that dressings of 90 lb. nitrogen per acre show increased yield and profit, but the increase over the yield given by 60 lb. is not very great, while there is a risk of cold-induced sterility or ' straight head ' due to delayed maturity.

Green manures

Less nitrogen is applied following a green manure crop. Probably about 20% or more of Californian rice is sown following a green manure crop of the purple vetch, *Vicia atropurpurea*, or the common vetch, *Vicia sativa*. Critical study has shown[3] that there is ample justification for this practice, in terms of rice yield and in the prevention of immobilisation of soil nitrogen, due to the high organic content of rice, residues. The vetch crop also assists earlier drying out of the soil in spring, and so permits earlier land preparation.

About 40 lb. of vetch seed is broadcast by aeroplane over the standing rice just after draining for harvest. The vetch then grows in the residual flood water until the arrival of the winter rains. The practice has come to the fore with the change from alternate rice, cropping to continuous rice, brought about by high production costs and land values.

Sowing and water management

Sowing takes place from mid-April to mid-May. Rice was formerly sown in California by drilling in the seedbed, followed by a heavy initial irrigation and draining; then, after two or three lighter irrigations, the water was held at a depth of 2–3 in.,

the depth being increased to 6–8 in. as the plants grew.

It is now common practice, following the drilling of the fertiliser into the seedbed, for the land to be flooded; then, within a day or two of flooding, the rice seed is sown from the air into the standing water, which is maintained without draining until harvest.

About 85% of all seed sown is pretreated with sodium hypochlorite solution to improve germination. Aerial sowing is done by specialist firms under contract. These firms use small biplanes of early vintage, which are used both for sowing and dusting the crops. The pilot works in conjunction with a flagman or marker on the ground, who indicates the line for the next traverse, and a high degree of accuracy is thus obtained.

Weed control

From the earlier practice of starting the water level at a depth of 2–3 in., and subsequently raising it with the growth of the crop, opinion now tends to favour flooding at a depth of 6 in. from the start and maintaining this level until harvest. Increasing the initial depth of the water assists weed control, while the large body of water in the rice fields has some effect in locally moderating the effect of the wide diurnal fluctuations in temperature mentioned earlier. Over the whole season, about 5 acre-ft. of water are required by rice in California.

Weed control has been a serious problem from the commencement of rice growing in California – a problem that has not yet been solved, despite much research. Spraying with the hormone weedkillers – 2,4-D or MCPA – is adopted, the correct time having been found to be at the initiation of jointing stage of the plant, when the topmost node commences to elongate, some 55–65 days after sowing. Nevertheless, rice can easily be damaged by these sprays and they are only of limited value for the control of the two most serious weeds – water grass, *Echinochloa crus-galli*, and spike sedge, *Eleocharis palustris*. For these, maintaining a 6-in. depth of water from the time of flooding until the harvest has been found the best means of control. Grazing the levees with sheep helps to restrict the spread of water grass from well-established centres, but this is not generally practised due to the difficulties of fencing, and the need for supplementary grazing and for the supervision of the flock.

Drainage

The provision of adequate drains for draining the land at harvest, and in the spring following the winter rains and floods, is as important as ensuring the adequate capacity of the service ditch for the initial pre-sowing flooding. On very flat land difficult to drain a grader-dug drain may run through all the checks to the lowest part of the field. At harvest the levees are then breached where they cross the drains.

The draining of the fields commences from mid-September onwards, depending on the season. Normally irrigation water is not taken in for about a week or 10 days before draining so as to reduce the amount of water to be drained and also to reduce the pressure on the drainage system. To ensure rapid and thorough drainage without leaving pools it is common practice to break open the levees, particularly where they cross the drains in the very flat fields. To speed up the operation and eliminate manual labour the levees are sometimes blown with dynamite.

A high-yielding variety of rice

Yields

Yields of rice, according to Grist,[4] vary considerably in the different countries of production, ranging from over 3,500 lb. per acre in Spain to about 550lb. in some tropical countries.

In California, under the conditions of intensive cultivation described above. yields now vary from 2,000 lb. to well over 6,000 lb. of paddy rice per acre, according to the fertility of the soil, the level of nitrogen fertilisation and the weather. The average yield is probably about 3,800 lb./acre.

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Afghan Irrigation Project

According to *Soviet News*, an agreement was signed on 19 January, 1960, by the U.S.S.R. and Afghanistan whereby the Soviet Union is to provide technical assistance to Afghanistan in building the Jelalabad irrigation canal. The Jelalabad project incorporates an 11,000-kW. hydro - electric station, water intakes and a 43-mile canal, five bridges, three aqueducts and other installations. The project is expected to make possible the irrigation of 64,500 acres of land, including over 50,000 acres of virgin land.

Cut-Price Survey

Two ex-Air Force pilots on the staff of Fiji Lands Department recently carried out an aerial photographic survey on the island of Viti Levu, on a 'do-it-yourself' basis, which has saved the colony many thousands of pounds.

Their survey covered 38,400 acres and cost only £650. If such a detailed survey had been done by ground methods, it is estimated that it would have taken about two years and cost about 30s. per acre – over £57,000.

The survey was carried out with a Drover aircraft hired from Fiji Airways; photographic equipment was borrowed from the Royal New Zealand Air Force and an enlarger was salvaged from unserviceable stores.

Ambassadors of Goodwill

Six young Australian farmers, including two girls, winners of the 1960 P. & O. 'Canberra' award, are now travelling through Britain, visiting agricultural institutions and studying farming methods.

Inland Waterways in the U.S.S.R.

Their Importance in Agriculture and Forestry

W. LINNARD, M.A.

Probably in no other major country in the world are the basic industries of forestry and agriculture more dependent on inland waterways, both natural and man-made, than in the U.S.S.R.

IT has been calculated that the U.S.S.R. has more than 100,000 rivers, the total length of which is 2½ million km. This system of natural inland waterways is almost twice as long as that of the U.S.A., Germany, France and Holland taken together. The figure of 2½ million km. does not take into account the length of canals constructed for irrigation and communications, nor the inland seas and countless lakes of the U.S.S.R.

Pipelines of part of one of the irrigation systems in Azerbaijan in the Caucasus

Photo: F. Shevtsov

Water for Agriculture

In agriculture, inland waterways are of twofold importance, firstly as a means of providing water for irrigation, and secondly as a means of transport for agricultural produce. While there are other alternative means of transport, there are often no other practicable alternative means of irrigation, and consequently inland waterways assume by far their greatest importance in the drier areas of the U.S.S.R., where crops must have extra water during the growing season or perish.

These dry areas are principally the southern part of European Russia, the Caucasus, and the group of Central Asian Republics between China in the east and Persia and Afghanistan in the south, namely, Kazakhstan, Turkmenistan, Tadzhikistan, Uzbekistan and Kirghizia.

Azerbaijan, in the Caucasus, boasts the great Ordzhonikidze canal network for cotton irrigation. The system is fed from the Arak river and covers an area of approximately 700 sq. km. Other smaller canal networks have been based on both sides of the Arak river to irrigate a wide variety of sub-tropical crops, such as melons, citrus fruits, cotton, grapes etc. Near Tiflis, in neighbouring Georgia, a large canal system has been developed on the Kura river, also to irrigate sub-tropical crops, and water is taken from some of the systems for overhead irrigation in the tea plantations.

In many parts of southern Russia grain can only be grown fairly near the rivers and the main irrigation canals have their banks stabilised by plantations of willows and poplars.

However, it is in the semi-desert areas of Central Asia and the south-east of the Soviet Union that the real importance of the rivers and their attendant canal networks is seen. In the Fergana valley of Tadzhikistan, cotton, rice, grain and also fruit are grown with the aid of extensive, and in some places very ancient systems of irrigation.

Flood irrigation is practised along the rivers Amu Darya and Syr Darya, which flow through the great deserts to the east of the Aral Sea. The highly developed irrigated agriculture of this region enables two crops a year to be harvested, usually wheat and barley first, and millet and lentils in the autumn. The agriculture of all the main centres in this area, Tashkent, Samarkand, Bokhara and Stalinabad, would be impossible without irrigation, but where water has been provided crops such as grapes, lucerne, citrus fruits, cucurbits, rice, carrots, onions and grain grow extremely well. Tobacco, too, is being introduced in some places.

The mighty Chu river, which rises in the Tian Shan Mountains and flows a great distance before drying out completely in the south Kazakhstan desert, supports a diverse agriculture in its valley. Canal systems

leading from the river make it possible to grow rice, corn, barley and millet, peaches, apricots and grapes, pumpkins, cucumbers, tomatoes and water melons.

Silting is a great problem in most of these irrigation systems and considerable importance is attached to stabilising the sloping banks of the main feeder canals with shrubs and trees, which themselves benefit from the irrigation water and form an important source of timber for agricultural uses in an otherwise very thinly forested region.

The importance of rivers for transport of agricultural produce in the Central Asian Republics is limited. Frequently the rivers dry up in the deserts, and even those which do not, rarely lead to any centres of population. Added to these disadvantages, the rivers are shallow, sluggish and change course frequently, leaving sandbanks and shoals which make navigation hazardous. In southern Russia and the Ukraine, however, the rivers are extensively used for the transport of produce. Notable examples are the Don, Volga and Dnieper. Grain, particularly wheat and maize, can be carried in bulk for vast distances relatively cheaply.

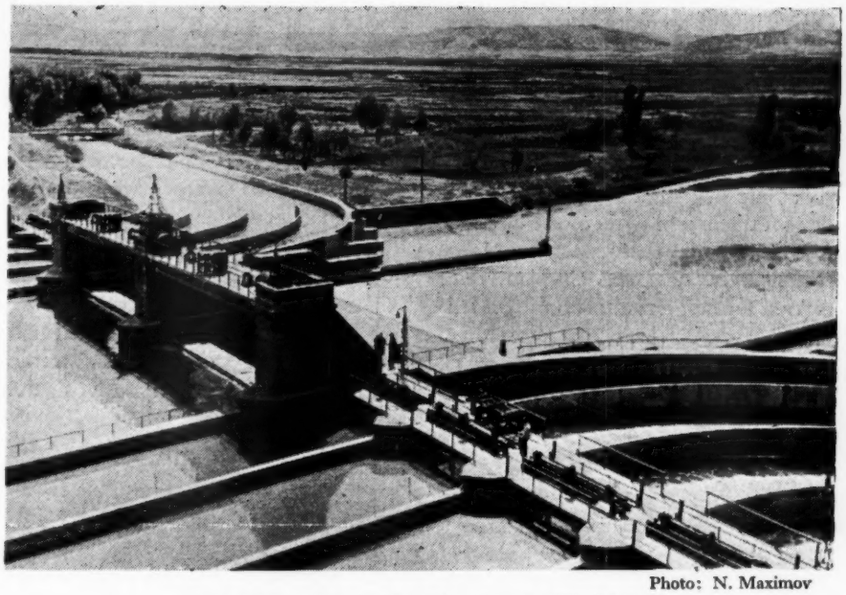

Photo: N. Maximov

Irrigation works on the Chu river in Kirghizia

Water for Forestry

In forestry, rivers are of triple importance: firstly, as a means of transport; secondly, as a source of irrigation water; and thirdly, as a source of power. The principal forest zones of the country are in Northern European Russia, Siberia and the Far East, and it is in these regions that the rivers have been most fully developed as a means of transport. Some 400,000 km. of rivers can be used for timber floating, and in 1957 over 55% of all the timber felled in the U.S.S.R. was transported by water at one stage or another. In 1955 floating was done on 2,400 rivers and about 200 lakes in the U.S.S.R.

The rivers themselves largely determine the method of transport. On the larger rivers like the Volga, Kama, Angara and Amur, navigable by seagoing vessels and carrying much traffic, the most practicable method of transporting wood is in large compact rafts towed by one or more powerful tugs. The rafts are usually formed of bundles of tree-length logs, bound with wire ropes at the big floating depots, and can contain anything up to 20,000 or 30,000 cu. m. of timber. Gangs of men live aboard these rafts while they are being towed to attend to the cables and tackle, steering gear, anchoring, navigational lighting and so on. On the Volga-Kama river system, timber can be floated for distances greater than 3,000 km., though the average floating distance is much less. In 1956 more than 50% of all wood floated was in rafts.

Loose floating is perhaps a less satisfactory method. The trees, after being felled and trimmed, are skidded to the launching points along the rivers and 'watered'. From then on the logs are left to be carried downstream by the current until they reach their destination and are held up by a boom. This method of floating involves considerable losses of timber. Many logs sink and others are left stranded on the river banks, shoals or mudbanks. Serious log jams can also occur, which result in breakages and delays.

A third method of floating is intermediate between loose floating and rafting. This is transport by bag-boom. A bag-boom is a long flexible boom made of timber, chains and hawsers. The boom is drawn around a mass of loose logs floating on the surface and the two ends are brought together and fastened. The boom and its contents are then towed along by a tug. The boom enclosing the logs assumes a pear-shaped form like a bag, which gives this method of transport its name.

The fourth method of wood transport by inland waterways is by ships or barges. In 1956 only 7.6% of all timber floated was transported in this way, but this is slowly increasing. This is because of the increasing numbers of hydro-electric dams being built on the main rivers of the Soviet Union, such as the Yenisei, Kama and Volga. Ships can travel along the rivers and pass these obstacles via locks, but it is clearly impracticable to construct locks capable of taking log rafts which may be anything up to a quarter of a mile long, to say nothing of the difficulties of manoeuvring. Cost analysis has shown that it is quicker, safer and cheaper to ship timber from the Upper Kama river to Stalingrad, a distance of 2,350 km., than to raft it, even if the ships have to make the return voyage empty. If other freight – for example, grain from the rich black earth of the Saratov region and the Ukraine – can be carried on the return voyage, the enterprise becomes correspondingly more profitable.

A further reason for the increase in the percentage of timber carried by ships is the large lakes and seas in the Soviet Union which have to be crossed. For example, on Lake Baikal, which is some 600 km. from end to end, severe storms blowing up suddenly can easily break up log rafts, with considerable danger to the tugboat crews, not to mention the losses of timber and expensive rafting tackle. Under such circumstances, shipping the timber is far safer than rafting it.

Other inland waters, where shipping is gradually being preferred to rafting, are the Caspian and Black Seas.

Reafforestation

As a source of irrigation water, rivers are of prime importance in the dry south-eastern parts of the country. Records show that many of these regions, *e.g.* near the Caspian, once carried forests, but indiscriminate felling and grazing have destroyed them and for a hundred years or more no trees have existed there. Now drought-resistant species, such as *Populus simonii* and *Elaeagnus*, are being established, and, where furrow irrigation is possible, oak, ash and maple are being introduced. It is hoped that once these shelter-belts become well established the snow which they accumulate in winter will make possible the raising of agricultural crops in the fields between.

Large plantations of fast-growing tree species are also being established along the Volga-Don canal, and in the sandy areas near the mouth of the river Dnieper, where water can be made available to give the trees a start.

Electric power

The third important influence of the rivers on Soviet forestry is by the provision of power in the form of hydro-electricity. The new dams now under construction are enabling the primary forest industries, such as pulp mills, sawmills, plywood factories and so on, to be set up close to the forests which supply them with their raw material, instead of being situated as now, mainly in the relatively thinly forested areas of western Russia.

For the first time vast untapped forests can now be exploited economically. This is particularly so in Siberia, where, for example, to clear the site of the Bratsk reservoir on the Angara river some 38 million cu. m. of timber are being felled and moved. To convert this colossal amount of wood, whole new industries are being moved to the area and once the dams are completed cheap electric power will be available for the factories, based on the immense forest resources of the surrounding region.

Photo: M. Ozersky

Log assembly prior to rafting on the Kama river

Photos: *Soviet Weekly*

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Transforming a Dry Area

' If the British irrigation engineers of 50 years ago who drew up a flood control plan covering 12,000 sq. miles in the Gal Oya valley could see what has been done in the past 10 years by the Government of Ceylon, assisted by various international agencies, they would sit up and cheer in their graves ', said Professor Evan A. Hardy* in a recent interview.

International co-operation

' In this vast development project the Government have been helped by the Colombo Plan countries, by the International Co-operation Administration of the U.S.A. and by FAO ', he continued. ' New Zealand provided £500,000 to build and equip the Dry Zone Agricultural Experimental Station, while in the case of the Technical Training Institute the U.K. has provided £50,000 worth of laboratory equipment, with Australia, Canada and the U.S.A. contributing farm equipment, libraries and machinery '.

Seven earth dams have been built to provide flood control reservoirs and three more are to be built this year.

' That will leave one dam to be built later ', he said. ' Meanwhile, more than 40 villages, each containing 150 families, have been established in the area and 25 new villages will be established in the next two years '.

One result has been the expansion of rice growing in the area. This, in part, has been achieved by planting the paddy in rows, using selected fertilisers and introducing weed control. There are now some 500,000 acres of waterlogged land for rice cultivation in the dry zones with a good productivity per acre. All this has radically altered the rice situation in the dry zones of Ceylon. For example, in 1952 the farmers of the Gal Oya valley had no rice to export after meeting local demands, but this year they will be sending out one million bushels.

*Professor Evan A. Hardy, formerly Head of the Agricultural Engineering Department, University of Saskatchewan, Canada.

New Weather Centre

An Institute of Tropical Meteorology to serve all countries in tropical Africa is to be built near Nairobi by the American Munitalp Foundation at a cost of £40,000. It will work in close co-operation with the East Africa Meteorological Department and the E.A.A.F.R.O.

Water for Irrigation in the Po Valley

DOUGLAS WOOD, A.R.S.M., F.G.S., A.M.INST.P., M.(RHOD.)I.E.*

THE Italian province of Forli, part of Romagna, includes a portion of the plain of the Po valley and some of the northern slopes of the Appenines. The section on the plain is thickly populated and is of considerable economic importance to Italy as a fruit-growing region. There are also a number of agricultural and industrial undertakings of lesser importance and the coast is an international summer resort. In 1957 fruit, potatoes and vegetables were exported to a value of no less than £100 million. These all need water for their growth and an assured and, if possible, an increasing supply is therefore of vital importance to the region.

Water supply is more or less a constant, but demands upon it from agriculture, industry and an increasing population are expanding.

Water for irrigation

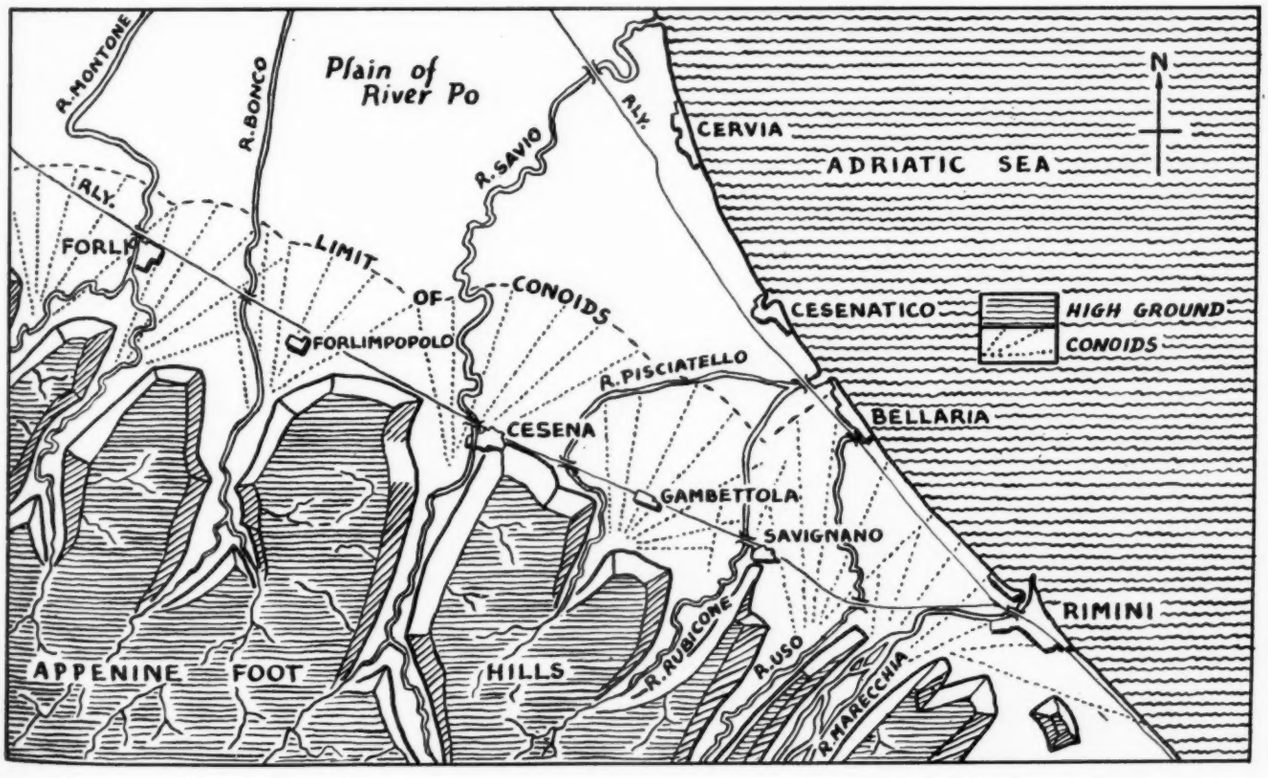
Rainfall on the Appenines is reasonably high, the mean annual being in excess of 30 in. But the climatic cycle does not correspond with the needs of the crops and for three months during the dry season the cultivators must resort to irrigation. Much of the plain is covered with a network of irrigation canals of various sizes. Some of these derive their water from rivers which rise in the infertile Appenines and flow in deeply incised valleys northwards to the plain, where they take a topographically less spectacular course through the rich cultivated lands to the Adriatic Sea. There are no less than seven of these rivers in the province, including one reminiscent of our school days, the Rubicon.†

Because of the seasonal rainfall on the mountain chain there is a long period during the year when the flow of these rivers is negligible. For this reason large tracts of the province would have to abandon growing crops were it not possible to obtain water from underground. This, in fact, is already being done, for there are great numbers of boreholes and wells; indeed, the fertile zone, some 10 miles wide, fringing the foot of the hills must be one of the most intensively drilled areas in the world. Most of this sub-surface water is used for irrigation.

From the production figures quoted above even a 5% increase in the

* The author is with the Harold T. Smith Organisation, Rome.

† Caesar's crossing of the Rubicon in 49 B.C. was tantamount to a declaration of war against Pompey and the Senate.



With acknowledgment to the Servizio Geologico D'Italia

The conoids of Forli Province, Northern Italy

quantity of water available for irrigation would give a very large monetary return, and there are several other factors which make the further development of sub-surface water of increasing importance. Governing the whole problem is the need for an inventory of the sub-surface water resources of the province and to this the provincial authorities are giving their earnest attention.

With the support of the Ministry concerned a survey is being undertaken, and it is planned in three stages. The first, now completed, is a geological survey concentrated on the hydrology of the region; secondly, and arising from the geological investigations, is a geophysical survey to obtain certain critical data; the third and final phase will be a programme of test drilling guided by the results of the geological and geophysical surveys. This will confirm or disprove the validity of previous assumptions and give definite information on which to evaluate the water resources.

With this data, the authorities will be in a position to formulate a sound policy for water use in the agricultural, civil and industrial sectors. Until the facts are known there can only be hesitancy in the further economic development of the province.

The geological survey

The geological survey started in the summer of 1958. It was completed during that year, together with a geophysical survey of the two extreme eastern and western sections of the zone, to which it directed special attention.

In brief outline, the geology affecting the area consists of three elements. The Appenine foothills are of Miocene and Pliocene limestones and marls; these, as is evidenced by the scarcity of vegetation, are little permeable. In consequence, precipitation in this catchment area has only two of the main natural methods of dispersal — evaporation and run-off. The latter, through the channels of the seven rivers and their affluents, is carried to the fringe of the plain; here some of the water continues on its course to the sea, intercepted here and there by canals and other artificial works. Of great importance is the fact that much of the flow disappears underground as these rivers reach the plain and is there stored in the porous bodies, sands gravels and of the 'conoids'‡ which precede the plain proper.

These conoids are, in effect, alluvial fans – vast accumulations of detrital material and clays – the results of cycles of deposition consequent upon erosion in Pleistocene times by its own river system of the Appenines behind. Covered by a final capping of clays which merge with the clays of the plain, the conoids give no surface evidence of their existence, except by a slight convexity of their forward slope and in sections exposed in the river valleys towards their apices.

Hydro-geological investigations

The vast number of wells which have penetrated these conoids should have provided a wealth of detail on their structure. Unfortunately, there are practically no records available – they have either not been kept or have been lost – so that it has been necessary to take oral evidence of depths, formations and yields of wells drilled many years ago in various ways and often using primitive equipment. To add to the difficulties of this investigation there is no list or map, showing the position of all the wells.

Investigations of this nature among the various small drilling firms which have operated in the area were supplemented by the co-operation of various public bodies able to contribute relevant data. In one case, the authority responsible for issuing certificates of potability proved a valuable source of information and many wells were traced through this agency, which could also furnish chemical analyses of their waters. Finally the survey was extended and many gaps were filled by application for well data to the water consumers – the industrial establishments, factories, refrigerating plants, agricultural estates, large, medium and small farms and nurseries.

A large amount of information was thus accumulated; from its analysis it was found that the conoids rest on alluvials of marine or lacustrine origin which form the plain itself. Thus the conoids were probably deposited contemporaneously with some of the more generally clay-like sediments of the plain. The concealed north-eastern limit (towards the plain) of the conoids can be only approximately drawn: they are in places contiguous; elsewhere gaps occur between them, distinguished by infillings of impermeable clays. Four water-bearing zones have so far been recognised or correlated in the wells investigated. They are formed of sandy and gravelly horizons in the conoids.

The third geological element has already been mentioned. It is the alluvials of the plain, a part of the Po valley. Deep drilling for natural gas has contributed to knowledge of these sediments whose thickness ranges between 1,300 and 1,600 ft. Two water-bearing zones have been recognised. Their recharge suggests that they are in some manner connected with the mechanism which supplies water to aquifers in the conoids.

Geo-physical investigations

After the conclusion of these investigations a geophysical survey of the conoids was begun. What this survey will establish is the impermeable clay surface on which the seven conoids rest. From this it will be possible to see which areas hold promise of further water resources in the deeper sections of the conoids not as yet touched by the drill. Sufficient information is already to hand in parts of the zone for drilling to commence and provide final confirmation of the geological and geophysical hypotheses. The conoids are, in the first place, the most probable sources for further water supplies within economic depth.

Declining yields of water

An alleged general decline in the yields of existing wells suggests urgency in completing the assessment at which this project aims. Drilling is at present uncontrolled, as is also the extraction of water. This could have serious consequences and a general and increasing depletion of the aquifers might be suspected or feared. Pumping the aquifers is limited to about three months in the summer; it is intensive and uncontrolled, as these are unfortunately the dry months, when no rain falls in the catchment area. The aquifers then undoubtedly suffer serious depletion, for not only have agricultural needs to be met, but also industrial requirements and the demands of the tourist population too are at their peak.

(*Continued on page* 138)

‡ Conoid: approaching a cone in shape.

Paints in the Tropics—2

P. WHITELEY, B.SC., A.R.I.C.*

Part 1 *was a general discussion of the causes of deterioration of paint in the tropics. The author here goes on to discuss the application of paints, distempers and limewashes.*

In general, metal surfaces require very similar treatment to that in any other part of the world, but wall surfaces and timbers may need variations in their choice of paint. Thus iron and steel will have to be cleaned by the best available method and primed with one of the recognised primers. Galvanised iron roofs are very commonly used and so assume special importance. Their treatment is often neglected and the weathering process which assists painting, may have to be omitted, or else it may be ineffective in dry areas.

Timbers tend to be either light and porous, with high absorption, requiring an oily primer, or hard, resinous or oily, requiring a hard primer with sealing properties. They are also often rough and badly finished and impossible to bring them up to English standards of painting with only a three-coat system, stopping and filling being almost unknown.

Internal and external walls

Wall surfaces may be very different in nature from British construction; internal and external plastering is generally by sand and cement, and gypsum plaster is rarely encountered. The finish is usually rough and porous, leading to very poor spreading rates for most paints. Thus emulsion paints are often found to cover less than half the area claimed.

A poor finish and gritty appearance may result from perfectly satisfactory paint. Further, the use of unwashed sand, even of sea sand, is common and gives rise to far more problems of discoloration, patchiness, bleaching, efflorescence and even saponification than are met in Britain.

External walls of older buildings

Limewash has a pleasing appearance in dry climates, as used here on earth walls in Zaria, North Nigeria

may have been finished in a weak lime plaster with multiple coats of limewash or cement paint and become difficult to paint except with the same materials. Newer structures will usually be in a stronger cement rendering or concrete (precast or blockwork) and may be less difficult to treat than the internal walls, where a higher standard of finish is necessary.

Strong algal growths causing discoloration require treatment, *e.g.* by copper sulphate solution, and removal before previously painted surfaces can be effectively redecorated.

Paints for the tropics

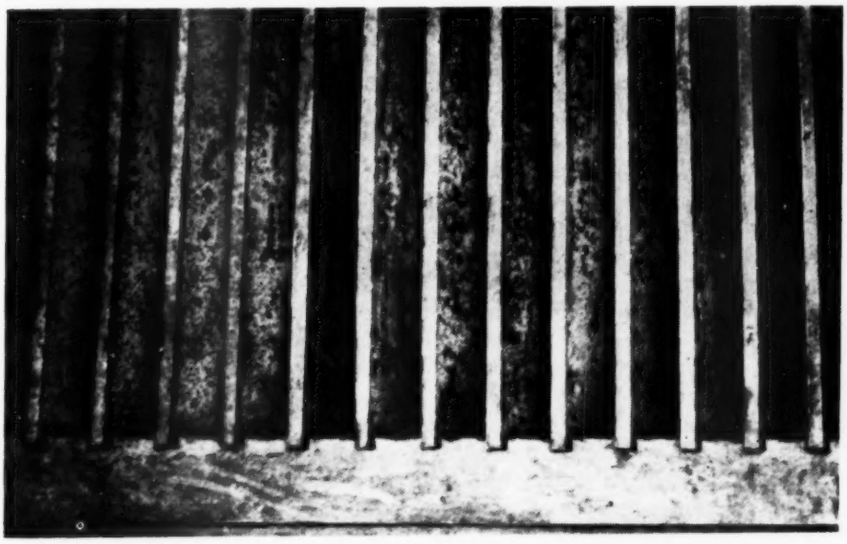
There is quite a wide variation in composition and performance of all classes of paint, more so than of most building materials, which is reflected partly, but not entirely, in the price.

Initial economies in the paint will generally lead to a higher future expenditure and it must be always remembered that the cost of putting on the paint (and taking it off if it has failed) is far greater than the material cost, even where labour is cheap.

Primers

A primer has special functions related particularly to the type of surface and must be chosen for this reason. When the correct primer is applied to a properly prepared surface, differences in quality of the finishing coat are minimised and the life of the whole scheme increased many times. With a suitable range of primers for, say, wood, steel, galvanised iron and wall surfaces the same undercoat and gloss finish may be used on every surface inside and out.

*Tropical Paint Research Fellow, Building Research Station of the D.S.I.R., Watford, England.



Mould growth developed on this white paint in Accra in three months

For wood

The normal white lead or white lead/red lead (pink) primers perform quite well on soft woods, but may prove unsuitable on oily or resinous wood, allowing the oil to exude through the film. As an alternative an aluminium pigmented primer should be used; variation in composition and performance, not defined by recognised standards as are the lead-based paints, makes the choice of aluminium wood primers rather difficult, but there are many good brands available. Some, however, may sink too greatly into soft woods or others fail to penetrate enough to give good adhesion.

For steelwork

The traditional red lead probably represents the best all-round primer for steelwork, with good anti-corrosive properties and a degree of tolerance to badly prepared steel and adverse climatic conditions at application. Red oxide/oil primers are in a lower category; with no anti-corrosive pigment they rely on an adherent, fairly thick coat of low permeability to prevent corrosion.

Unfortunately, no paint seems to have been more abused or debased than ' red oxide ' and some very low-grade materials are found. In particular, most of the quick-drying red oxide primers, often used as shop primers on structural steel, are not merely useless, but are detrimental to subsequent painting and should be removed completely before the steel is finally painted; they are often applied over badly prepared and scaly steel.

Red oxide primers containing zinc chromate may have useful anti-corrosive properties and are often used where speed of drying is important. They require very thorough cleaning of steel to obtain good results and may also be used on non-ferrous metals.

Several other anti-corrosive primers have been introduced in recent years. Calcium plumbate is claimed to have good rust inhibition and to prevent blistering; it has already proved to have excellent adhesion to zinc surfaces. Metallic lead primers may give better performance than red lead in coastal areas of serious salt corrosion. Metallic zinc primers (' zinc-rich ' or ' cold galvanising ' paints) are also capable of a high degree of corrosion resistance when properly used.

When maximum protection and life is required for vital structures recourse should be made to metal spraying, followed by a full painting scheme. This process is, of course, far more expensive than painting and should preferably be carried out on structural members before shipment.

For zinc

Zinc is the second commonest metal surface to be painted in the tropics and has always been a source of difficulty. The normal recommendation of a period of about six months' weathering to assist adhesion and remove greasy deposits may be impossible or ineffective in dry areas.

Recourse to mordant washes is normal practice, but acid etches are not always properly removed and copper sulphate solutions may actually increase corrosion of the steel. There is much evidence that calcium plumbate primers will overcome these difficulties, even on new surfaces, which should be thoroughly degreased, either with thinners or with a strong solution of household detergent. Zinc chromate primers are sometimes successful, but rather variable.

For aluminium

Aluminium is rather easier to paint than zinc, but it also requires thorough degreasing. A zinc chromate primer is the most useful type; lead-based primers should not be used on aluminium.

Proprietary pretreatments are available for both zinc and aluminium.

For walls

Reliance should not be placed on even the best primers if the wall is new and still appreciably damp, or if dampness and discoloration are caused by ingress of water from the outside; it is wrong to apply an impervious coating in such conditions. A fairly highly pigmented type is preferable to overcome some of these surface defects, but there are differences in porosity of these primers as well as in performance, and two coats are needed to ensure complete coverage.

Cement and sand plaster should always be primed if gloss or flat finishes containing oil or alkyd resins are to be used, but chlorinated rubber paints and cement paint, distemper and PVA† emulsion paint may be applied directly. However, the sinkage, and sometimes the patchiness and discoloration troubles with cement plasters, lead many painters to use a primer even under PVA paints; in this case a thick coat leaving a glossy surface should be avoided, as adhesion of the emulsion paint may then be poor.

Alternatively, and more cheaply, limewash or cement paint have been used to fill the porosity. Again, only thin coats should be applied and the rough texture of the cement paint can spoil the smooth sheen of the emulsion paint, showing brush marks excessively.

Asbestos cement sheets may be treated as for other cement surfaces, with alkali-resisting primers, chlorinated rubber paints, PVA emulsion paints or distemper.

Decorative and protective finishes

For many years ready-mixed oil paints have constituted a large part of the materials used in the decorative trade at home and abroad. Their use is now greatly reduced, but still continues.

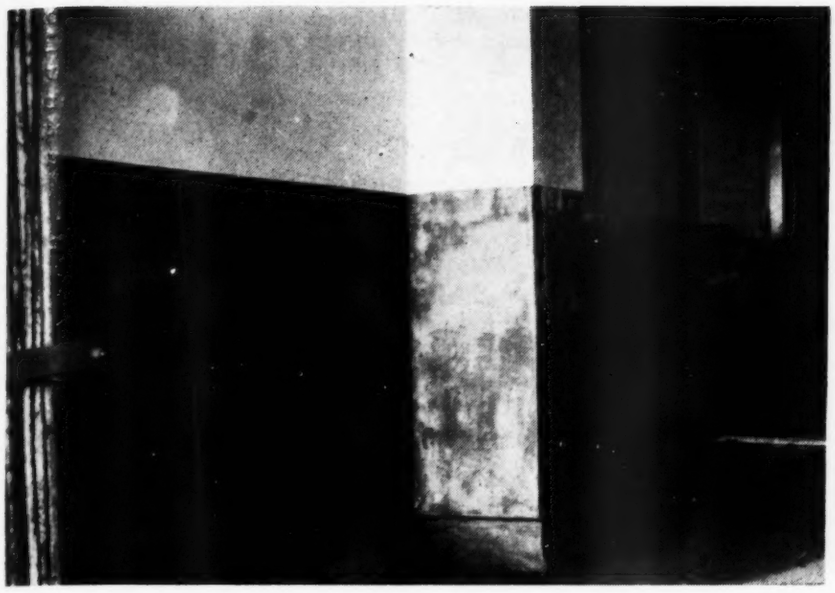
The durability of the plain oil types – white lead for protection, zinc oxide for retention of whiteness and freedom from mould growth in the tropics, dark colours for general use – is still considered to be high and, if B.S.‡ Specification paints are used, is predictable on the basis of much past experience.

However, the decorative qualities of oil paint are not of a high order (varnishing was commonly part of the process, but is not usually satisfactory in the tropics) and the demand for higher gloss, smoothness, hardness and faster drying has led to the introduction of hard-gloss paints – varnishes of various types pigmented with much lower quantities of pigment than the oil paints. The durability of the earlier types, based on natural or semi-synthetic resins, has proved doubtful and rarely adequate for tropical use.

The alkyd-based gloss finish

The modern alkyd-based gloss finish is, however, a very different product and at best, properly used, can have a very long life, maintaining its original decorative qualities for a considerable time. In white and pastel colours the darkening of lead paints is avoided.

† PVA: Polyvinyl acetate.
‡ B.S.: British Standard.



Saponification of gloss finish on the concrete in this basement has resulted from over-hasty painting, despite the use of a primer resistant to alkali

Liability to fungal attack, which is less than that of oil paints (except the zinc oxides), can be improved by the incorporation of fungicides, and such paints are now being marketed, although much experimental work is still in progress. The extra cost of these additions is high and must be considered in relation to the prolongation of decorative life. Their possible toxicity must also be considered in relation to the conditions of use.

The alkyd gloss finish is best used in conjunction with a suitable undercoat and should not be treated as a general-purpose paint for application to any kind of surface. New surfaces must be primed as described above; previously painted surfaces should be thoroughly washed, flatted and given a single undercoat.

Used as described, in a three-coat system, the alkyd gloss finish is equally suitable for all surfaces, wood, metal and walls, interior and exterior, and may be considered nearly as versatile as the ordinary oil paint, at least as durable and very much more decorative.

Aluminium paints

Where maximum protection is the aim, and appearance is less important, aluminium paints, based on alkyd or tung oil media, or dark-coloured paints containing micaceous iron oxide, are often preferred.

Distempers

The cheapest form of wall decoration, except limewash, distempers have been the traditional internal finish for many years and have given remarkably good service. The keeping properties have been made adequate to the severe conditions of shipment and tropical storage, the washability of oil-bound distempers has been improved and the general finish has been satisfactory. In some areas even dry distempers are still in use, but they cannot be said to give a satisfactory finish by today's standards.

The odour of distempers remains distinctive and not always pleasant, but the fault to be most expected, mould growth, does not seem serious, probably because of the large amounts of preservative normally incorporated. Nevertheless, there is an increasing tendency to replace distempers by emulsion paints in spite of the higher cost.

Emulsion paints

This rather general term is taken here to refer entirely to PVA-based paints, which are a most satisfactory form of wall finish. Very easy to apply, rapid hardening, with a pleasing finish and good resistance to dirt and scrubbing, using water for thinning and brush cleaning, with little and non-persistent odour, they are rapidly taking a large share of the market for interior wall decoration. Initial cost is still high, especially in view of their high water content, but wear and durability are good and reduce later repainting costs; the ability to take multiple coats, without flaking or the necessity to wash off, is an important feature.

Performance in tropical areas is generally very good. The porosity claimed for PVA emulsion films permits efflorescence and lime bloom to occur readily, and this is often regarded as a fault. These can, however, be readily removed and the porosity may save the paint film from disruption or loss of adhesion. Although alkali-resisting to a considerable extent, emulsion paints sometimes show patchiness and discoloration on new walls, and they must not be expected to be foolproof on walls which have not sufficiently dried out.

Resistance to mould growth appears good in most areas; certain paints incorporate a fungicide to increase resistance further.

Emulsion paints are also finding increasing use on exterior walls, the decoration of which plays a larger part in tropical painting than in Britain. Although more expensive than the traditional limewash and cement paint, a few have so far shown very good durability, and there is much less tendency to the algal growth which disfigures so many buildings in the hot humid areas.

Cement paints

The most commonly used exterior wall finish – cement paints – have provided a cheap and satisfactory decoration for many years. On sand/cement or earth/cement block construction they exert an essential waterproofing action, and their protective function extends to the better quality constructions as well.

Decorative effect varies with the colours used, some being more readily affected than others by damp conditions in the wall. Lime bloom and efflorescence often cause discoloration and apparent fading; removal is possible by washing with very dilute hydrochloric acid (after pre-wetting the surface with water), although this is a costly and difficult procedure for tall buildings.

Durability in the tropics is variable and fairly frequent repainting may be necessary; often heavy algal growth

is the main reason for repainting.

The use of a 1% copper sulphate solution for mixing the paint may prevent algal growth for some time, although staining may result, and some attempts have been made to increase the resistance of the paints by incorporation of suitable agents. ' Santobrite ', sodium pentachlorphenate, is frequently recommended to kill existing growths.

The tendency to regard cement paints as low-cost materials which can be applied by the poorest quality labour often leads to trouble. Incorrect mixing procedure and careless use are often the cause of premature failure. It is usually difficult to ensure complete hydration in hot dry areas, and unskilled labourers ignore the instructions to wet the walls first and to follow the sun if possible, resulting in powderiness and rapid chalking.

Limewash

The oldest, cheapest and most readily available material, limewash, is still extensively used; its high reflectivity, when dry, greatly assists in reducing the internal temperature of buildings and it has a pleasing decorative effect, although glare is often excessive.

The low initial cost is offset by the need for very frequent renewal, often twice a year, and various additives have been proposed to increase water resistance and prolong its life, the most popular being tallow and vegetable oils, as described in *Building Research Station Digest*, No. 17.

Summing up, it may be said that satisfactory service should be obtained in the tropics from most of the better quality paints in use today, but that this is dependent on reasonable use, including the correct primer, and greater attention to surface preparation than is usually given.

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Plans and Progress in India

The largest portion of the natural resources of India consists of land and the largest contribution – nearly 50% – to the national production is made by agriculture.

Out of the total population of India, nearly 400 million – about 70% – are dependent on agriculture as their principal means of livelihood. Besides being the source of food, agriculture supplies raw materials for some of the major industries, such as sugar, cotton and jute textiles, and also accounts for a large portion of the country's exports.

India enjoys a virtual monopoly in lac and leads the world in the production of groundnuts and tea. It is the second largest producer of rice, jute, raw sugar, rapeseed, sesame and castor seed.

The total reported area of land utilisation is 720 million acres. Of this, the net area sown comes to 321 million acres, or 44.6% of the crop area; food grains account for about 75%, oil seeds for 8.2% and cotton for 5.3%. The acreage under sugarcane covers about 1.4% and all the other crops taken together 9.7%.

Irrigated area

Out of the total area under cultivation, about 56 million acres are irrigated. Canals account for about 41% of this irrigated area, wells for 30% and reservoirs or tanks for 20%. The remaining 9% of irrigated area is covered by minor irrigation sources.

Five-Year Plans

Special stress was laid in the First Five-Year Plan on the increased production of food grains and important commercial crops like sugar-cane, oil seeds, cotton and jute.

The Second Five-Year Plan aims at diversification both in the principal sectors of the economy as well as within the various sectors of agriculture.

According to the targets incorporated in this Plan, it is proposed to raise production of food grains by about 23.8% and overall agricultural production by about 28% by 1960–61. Other percentage increases contemplated are: oil seeds 36.2%, sugar cane 34.5%, lac 33%, cashew nut 76.7% and tea 9%.

The measures for increasing agricultural production in this way include expansion of irrigation works, increased use of fertilisers and manures, an increase in the coverage of areas under improved seeds, and greater emphasis on intensive cultivation methods.

As a result of these and other steps marked development has been made in the production of commercial crops like cotton, jute and cashew nut. Progress in cotton output has been swift and a concerted programme of research and advisory work has brought cotton production to very high levels. In 1955–56 it rose to 4.5 million bales and in 1957–58 to 5.2 million bales.

Water for Irrigation in the Po Valley

(*Continued from page* 134)

There is one alleviating circumstance, for during the succeeding nine months rain falls, the rivers are flowing freely and recharge to their static levels the aquifers depleted during the summer. So the adverse effect of exploiting the aquifers when the rivers are low or dry should be reversed in the following months.

What, however, is still unknown is whether this recharge is equal to the total extraction. Until this has been ascertained there remains cause for alarm, not only for the possibilities of expansion, but also for the continuance of agriculture and industry at their present scale.

Test borings essential

Sub-surface geology and hydrology are often largely matters of inference and deduction, and it is only the drill and the pump which can ' see ' several hundred feet below the surface. It is on the skilful execution of the final phase of this rationally planned project that success will depend. If modern methods are adopted and this work is carried out with the same competence, versatility and attention to detail which has distinguished the work of the Italian geologists and geophysicists employed in the first two phases, success will be assured and will lead to similar planning in other areas, where, owing to some of the geological features referred to above, the country is classed as semi-arid.

Machines for Crop Production Under Irrigation—2

Land and Water Use Branch
Agriculture Division, Food and Agriculture Organisation, Rome

IN most farm irrigation systems water is delivered from river or canal through a watergate at the highest point of the land in the farm unit. From this point the construction and maintenance of ditches to carry water to the land is the responsibility of the farmer.

The types of ditches required fall into three main classes:

(*a*) primary or supply ditches, whose function is to carry water to the different sections of the farm;

(*b*) secondary, or what are commonly called 'head' or 'contour ditches', from which the water is distributed on the fields;

(*c*) waste or drainage ditches to carry off the surface run-off or to lower the water table.

FARM DITCHING MACHINES

In practically all cases these ditches can be constructed and maintained by relatively inexpensive equipment which can be operated by farm tractors of from 25–35 h.p.

In Part 1, machines and home-made devices for land levelling and smoothing were described. Here various methods for delivering irrigation water to the land and distributing and controlling it are reviewed.

The V-drag

This is probably the simplest of all ditching machines and is ideal both for the construction and maintenance of small surface ditches. It can either be made of wood or steel. A design for a home-made machine of this type is shown in Fig. 4.

In operation, a man stands on the runner boards and the position he takes controls the depth of the digging – the closer he stands to the front, the greater the penetrating action. By exerting pressure on the wing section through the upright handle provided he can also considerably control the slope of the bank. The width of the ditch can be regulated by varying the distance between the runner and the wing by adjustment of the spreader board.

The ditch is usually first marked out with a plough or a ridger. This also ensures better penetration of the drag. In hard soils it may be necessary to plough to the full depth of the ditch, in which case the drag acts only as a shaper or finisher.

Blade-type machines

Any blade implement which can be tilted and angled can be used for the

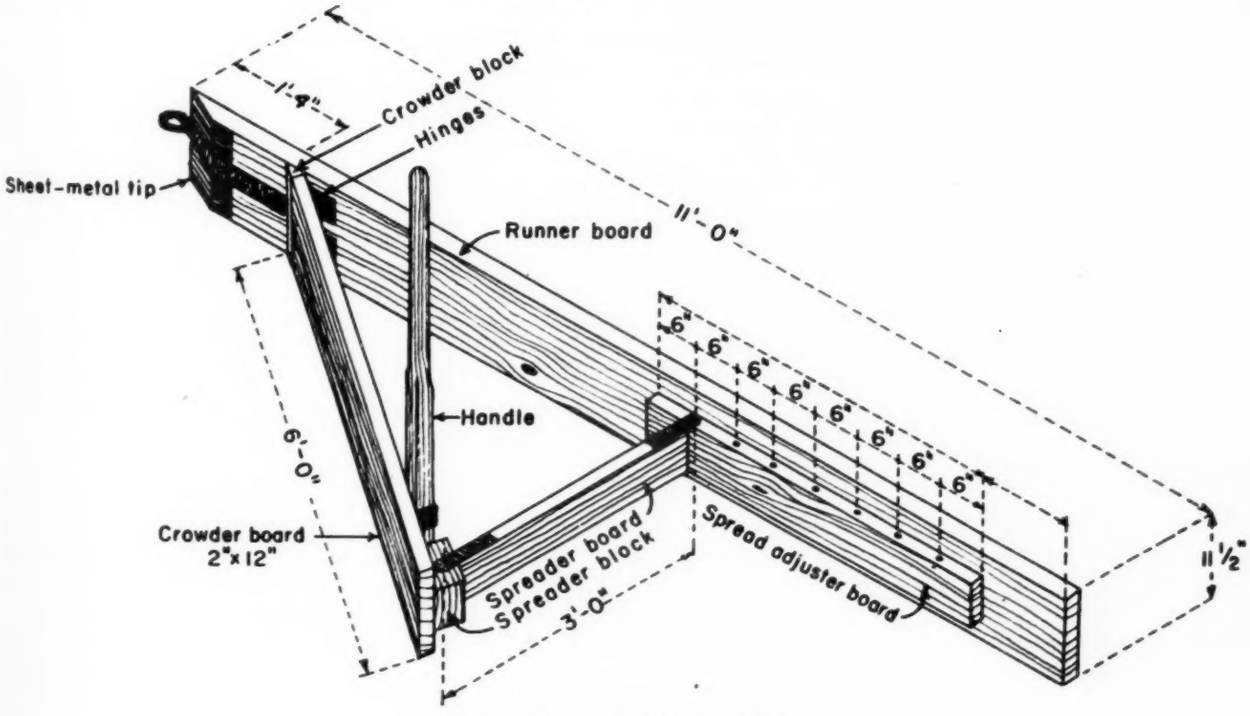


Fig. 4. Home-made 'V' drag ditcher

construction and maintenance of small ditches. Examples of these machines are rear-mounted tractor blades and the various types of road grader. This type of equipment is not specifically for ditching and should not be purchased for this purpose alone, as in most cases it is too expensive. Where such machines are already owned, or can be borrowed or hired, they can also be used for ditching.

Mouldboard-type ditchers

These are probably the most commonly used type of farm ditching equipment. They consist of a cutting share and double mouldboards attached to a heavy standard. They may be mounted directly on the rear of a tractor or may be carried on a separate wheeled frame. Various shapes of shares are available according to the shape of ditch bottom required, and on some models the wings or mouldboards can be adjusted to vary the shape and slope of the ditch banks. Depth of cut is controlled, either hydraulically or manually, by a lever or screw. A very wide number of sizes are available, ranging from small models capable of being operated by a normal farm tractor to very large types requiring heavy crawler tractors to pull them.

WATER DISTRIBUTION AND CONTROL

Water may be distributed on land to be irrigated by basically five different methods. These methods and the equipment commonly used with each are as follows:

Free flooding

This method does not involve the construction of any control structures in the area to be watered. The water is simply allowed to flow freely over the land from the head or contour ditches. It seldom produces an even distribution of water and is only recommended where the supply of water is plentiful and crop values per acre are relatively low. No special equipment is needed.

Border irrigation

This system is widely used for watering close-growing crops, such as small grains and fodder crops, on land which does not slope steeply. It consists of dividing a field by ridges or low bunds constructed in the direction of greatest slope. Water is admitted at the high end of the slope and is guided more evenly over the field by the longitudinal ridges. The ridges must be high enough so they will never be over-topped by the irrigation water, and should be wide enough so they can be crossed with farm machinery.

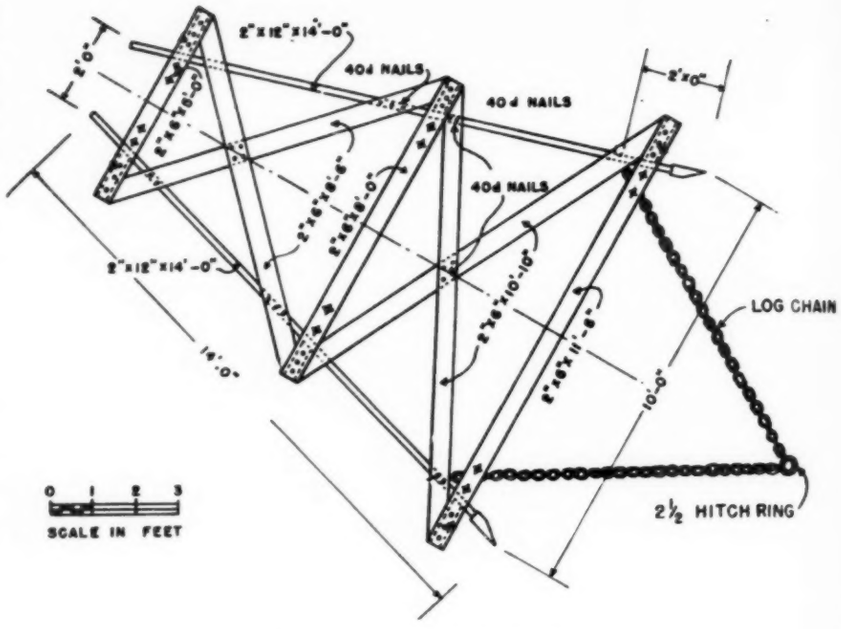


Fig. 5. Home-made border drag

A general rule is that the base width of the ridge should be about four times the height when the soil is settled. These ridges may be formed by using a border drag or a border disk. A recommended design for a home-made *border drag* is shown in Fig. 5.

A border disk consists of two gangs of disks mounted on a tool carrier, so that in operation they throw in and so build up a central ridge. Each gang is equipped with from two to four disks of varying sizes, the larger disk always being in the centre, as shown in Fig. 6. Each gang may be tilted and/or angled on the carrying bar, and the distance between gangs may be adjusted to form ridges of the desired height and width. This machine is also most useful in building up beds for crops sown in this manner and for breaking up and levelling old bunds when required.

After the borders or ridges have been formed the depressions left on each side should be filled by means of a grader or drag and cross slopes between the ridges should be eliminated. This can be done with a grader or with the scraper and cutting float shown in Figs. 1 and 2 and finished with the levelling drag or float shown in Fig. 3 (see Part 1).

Basin system

In this system the land is divided by ridges into separate plots or basins. It has been used on flat land and mainly on soils which absorb water very slowly. The system is also commonly employed to leach salts from areas being reclaimed. The size of individual basins may vary from a few square feet to an acre or more in area, depending on the type of soil, the crops grown and the cultural methods followed. This system is losing popularity because of difficulty in building the ridges with mechanical equipment and also in working the land mechanically.

It is difficult to employ machinery in forming ridges to enclose small plots. For large areas, however, the border drag and/or the border disk, particularly if it is tractor-mounted, can be utilised.

The corrugation system

This system is widely used on close-growing, uncultivated crops, such as small grains and forage, and particularly on land with considerable slope and on soils which have a tendency to pack or crust on the surface when water is applied by flooding. This consists in forming shallow, parallel

furrows on the surface after the crop is seeded. The depth and spacing of these furrows depend mainly on the nature of the soil and the crop being grown. Normally they are located from 18–36 in. apart and are usually from 3–5 in. deep. They may be run directly down the slope or, where steep slopes are encountered, may be run on the contour, in which case care should be taken that the cross slope never exceeds the down slope.

Corrugations may be made with home-made equipment as shown in Fig. 7, with special corrugator shovels attached to a tractor-mounted cultivator frame or a toolbar, or by means of special manufactured corrugating tools, an example of which is shown in Fig. 8. The type of tool which is most adaptable depends largely on the type of corrugation surface which is best suited to the conditions of soil slope, soil type and the crop being grown. On steep slopes and on soils which absorb water slowly a rough, open type of corrugation is desirable to permit rapid and even absorption of water through the whole length of the corrugation. Conversely, on shallow slopes, and especially on permeable soils, a smooth, somewhat packed furrow is preferred, in order to slow down the rate of water absorption, particularly at the upper end of the field.

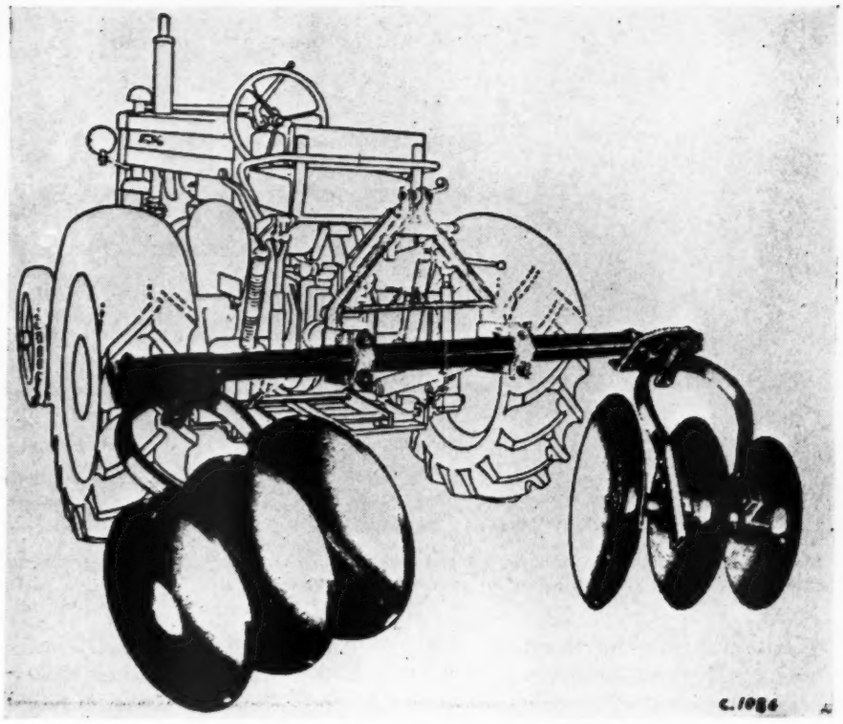


Fig. 6. Tractor-mounted gang of border disks

Furrow irrigation

Row crops such as corn, cotton, potatoes, sugar-beets, fruits and vegetables are practically always watered by this method. Water is carried down the slope by a furrow or furrows between the rows. The furrows are run straight down on moderate slopes. On more rolling land, however, they may, and usually should be, run on the contour. Furrows may be formed before or after the crop is planted. The practice in this respect depends on the crop being grown, particularly whether it is seeded or transplanted, and on soil moisture conditions at planting time.

In general, seeded crops are sown on the flat if soil moisture conditions are favourable at seeding time. Then, during subsequent cultivations, furrows are formed between the rows. When this method is followed, and particularly if the rows are relatively wide spaced, tools are used on the first cultivation which will form a shallow furrow much like a corrugation on each side of the row. This allows for good moisture conditions close to the young plants without the necessity of wetting the entire space between the rows. In subsequent cultivations, and as the plant matures, the cultivator

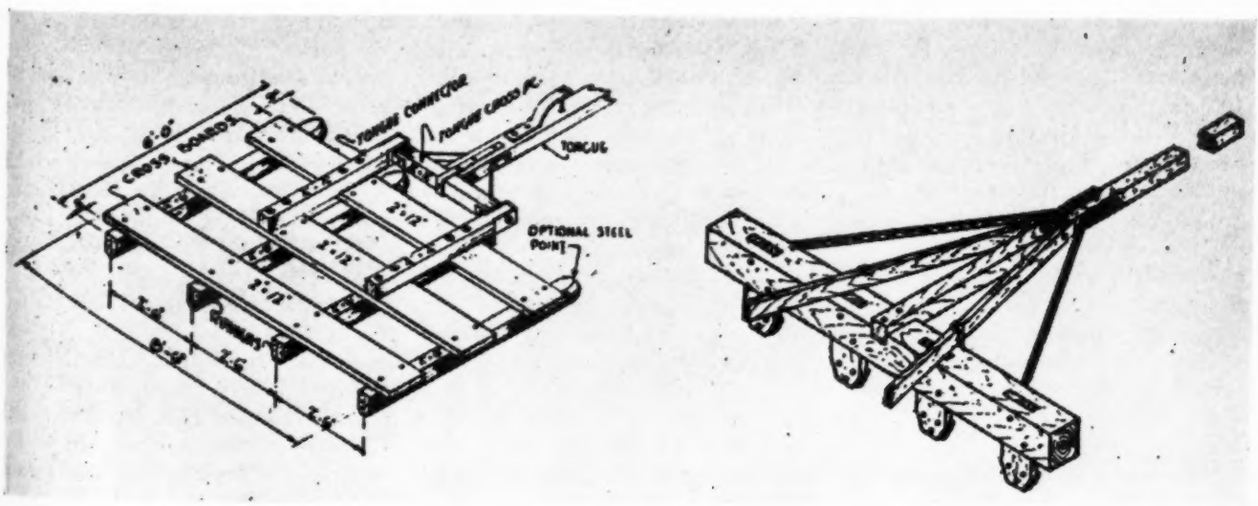


Fig. 7. Home-made land corrugators

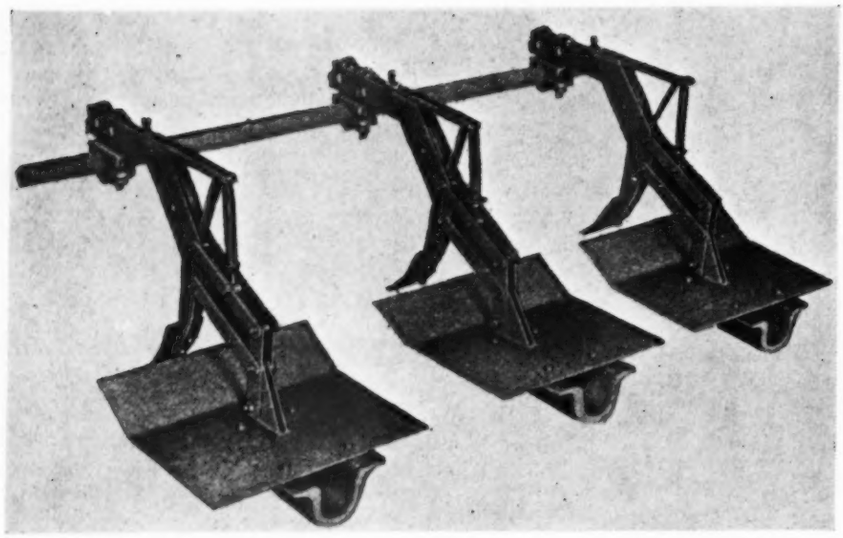


Fig. 8. Corrugators mounted on a tractor toolbar. Note the coulters for opening up the furrow in advance of the main tools

tools are changed to throw up soil towards the plants and leave a deeper irrigation channel midway between the rows.

When plants are transplanted, or particularly where irrigation water must be provided at the time of seeding, ridges or beds are thrown up and one or two rows of seed are sown on the top of these. For this operation a mouldboard-type lister is usually employed. For wider beds, on which two rows of a crop, such as sugar-beets or vegetables, are sown, a disk bedder may be used. This is very similar in design to the border disk previously described. When throwing up ridges, care should be taken that the operation is done sufficiently previous to the time of planting, and that the soil is in such a condition that the ridges will be settled and fairly firm at planting time.

Special cultivator shovels are required for weed control under this system. Normally they should be designed to maintain fairly deep, narrow furrows when the crop is young, and so they will be made shallower and wider as the crop matures. In some crops, however, such as sugar-beets, it is desirable to keep the furrows deep enough and narrow enough so that the water never comes in contact with the plants.

(*To be continued*)

Flavour in Tea

Ceylon tea, which represents 60% of Ceylon's exports, is to be highlighted at the new Ceylon Tea Centre, which was opened in Manchester on Tuesday, 8 March, by Mr. D. M. Forrest, Commissioner of the Ceylon Tea Centre in London.

Nearly one-third of all the tea drunk in Britain comes from Ceylon, where the tea plantations cover 570,000 acres and employ 520,000 workers. Nuwara Eliya, Dimbula, Dickoya, Matale, Uva are names of tea-growing districts synonymous with quality and well known to all connoisseurs of tea. The tea produced in each centre is individually identifiable by the professional tea taster, who is aware of the subtle nuances of flavour.

The Tea Centre, which contains a self-service tea bar and a waitress service tea lounge, is designed to influence the public to sample ' the best cup of tea in Manchester ' and to teach people how to make the perfect cup of tea. Manchester is regarded as a good market, due to the fact that in Manchester people get soft water from the Lake District and Wales, which brings out the aroma and flavour particularly well.

Cocoa in Fiji

Cocoa was introduced into Fiji in 1880 and again between 1905 and 1909, but a disastrous hurricane in 1912, coupled with low prices for cocoa and poor communications, led to the abandonment of the industry.

Following publication of an encouraging report by an expert in 1952 on the suitability of cocoa for cultivation in Fiji, a special committee recommended that cocoa growing should be revived as a matter of urgency. Consequently a survey of surviving trees was made and some six thousand were located, pruned and rehabilitated. Careful records showed that a nucleus of high-yielding trees was available and that the performance and quality of local clones compared very favourably with those of the best introductions from Trinidad, Papua–New Guinea and Western Samoa. By the end of 1958 sufficient seedlings to plant nearly 6,000 acres had been distributed to farmers.

An experimental fermentary and drier having proved satisfactory, similar units are to be constructed to process the crop until such time as a satisfactory marketing scheme for smallholders' cocoa has been evolved.

Technical News

Articles in the April issues of some of the other journals of the Leonard Hill Technical Group include the following:

Automation Progress.–'Automation in France' by P. Naville.

Dairy Engineering.–'The Strength of Bottles' by P. H. Smith; 'Practical Cleaning Routines for the Diary – 3' by E. Booth.

Fibres and Plastics.–'Mothproofing Textiles' by R. W. Moncrieff; 'Fibre Blending on the Cotton System' by W. Nutter.

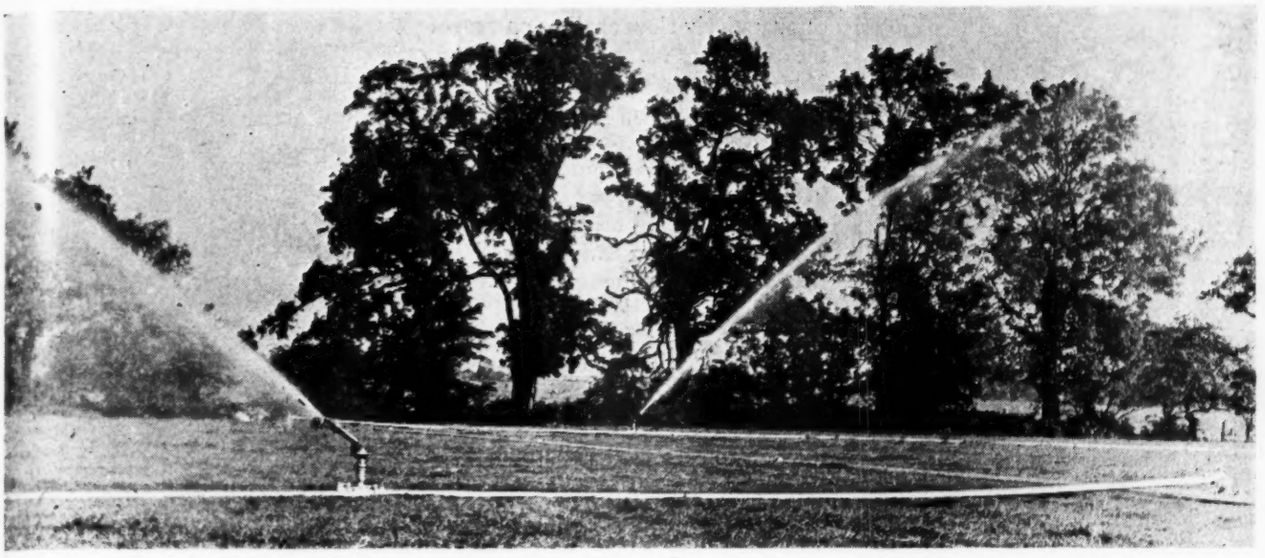
Food Manufacture.–'Annual review: Fruit and Vegetable Canning and Quick Freezing' by Dr. D. Dickinson; 'How Clean are Your Containers?' by A. H. Walters; 'World Food Supplies – 2' by Dr. F. Aylward.

Manufacturing Chemist.–'Worm Infestation – 2' by Dr. A. Mackie.

Petroleum.–'Wrapping Tapes for Pipe Protection'.

Public Works and Muckshifter.–'World's Biggest Bridge under Construction in New York' by M. Lorant.

Specimen copies of the above journals are available on application to Leonard Hill House, Eden Street, London, N.W.1.



Farrow model 50 rain guns irrigating grass on a Norfolk dairy farm

Cambridge Irrigation Conference

FIRM recommendations are not yet available on such matters as when to irrigate, how much water to use and how to avoid undesirable side effects.

There is, however, a wealth of personal experience available and the Cambridge Irrigation Conference, under the chairmanship of Prof. H. G. Sanders, provided a forum where irrigation experts, farm advisory officers and farmers could discuss the problems of the new farming techniques and exchange their experiences.

The following is a short summary of the papers presented, each of which was followed by lively discussion:

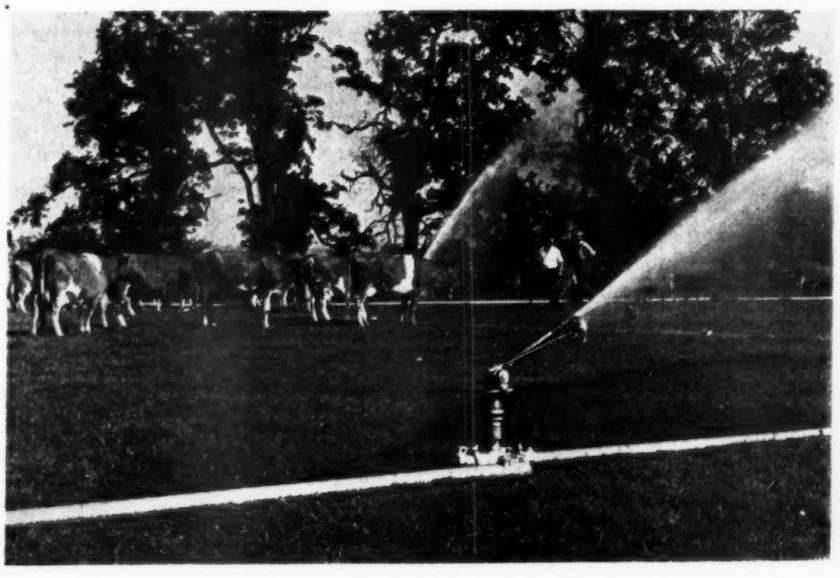
Water Supplies for Irrigation *by Colin Allsebrook (Water Engineer, Guthrie, Allsebrook & Co.)*

The simplest source of water for irrigation is a stream. If the flow is slower than requirement, it can be dammed, and even a small stream so harnessed for 24 hours each day can often provide enough water for eight hours' irrigation a day.

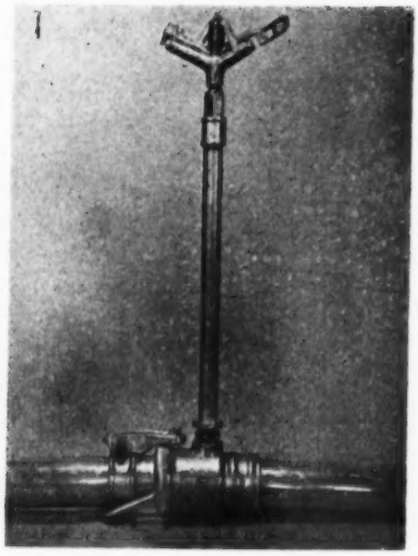
Where no stream exists, boring may be successful, but a knowledge of the geological substrata is essential. Some rock strata are porous and it is important to know where these layers are, where they come to the surface (where they will receive rain), which layer is likely to yield the required quantity of water and whether this water contains undesirable chemicals.

Where clay overlays a porous rock rain cannot percolate, and often overlaying strata of this kind fill the crevices in lower rocks which might otherwise yield water with silt derived from further away. Sometimes, however, it is possible even where crevices are silted to coax water from them by ' development ' pumping.

Normally it is no advantage to make a borehole larger than about 12 in. In most strata it is better to go to greater depth and thus tap numerous saturated and creviced layers than to make a large-diameter hole through a few layers. Lining of part of the hole may be necessary to prevent sides collapsing.



Cattle grazing on irrigated grass



Farrow P20 standard angle sprinkler and riser on 3 in. pipe

If a hard rock overlays sand, a saucer-like cavity, with the rock as a ceiling, can be created by sucking out quantities of sand-laden water. The pool thus formed usually remains sand-free and water can be pumped from it. Where no rock ceiling exists, the natural grit which may be mixed with the sand can be used as a filter, or if the sand is of even size a ' gravel screen ' can be inserted round the bore to give the same filtering effect.

Water storage by damming streams can be very successful. It is necessary to excavate a pond *below* the water level of the stream. Simply damming the stream may not *raise* the water level at all; it may simply force it to saturate surrounding ground. Such ponds can be dug by bulldozers, but a drag-line excavator is usually more suitable. An excavator can in a few days form a pond, say, 100 ft. x 30 ft. x 6 ft. to hold about 100,000 gal.

Choice of Equipment for Irrigation

by John Cyster (Sussex farmer)

There are two main types of distribution devices – sprinklers and rain-guns. Sprinkler heads of the single- or double-nozzle type are particularly useful for horticultural work. In agriculture they are ideal for young plants, resulting in larger crops where there is a high proportion of bare earth not covered by foliage, where the soil has a low absorption rate, and where such crops as potatoes are earthed up on steep banks. All of these conditions seem to benefit from the comparatively slow application rate of the sprinkler, *i.e.* 4–5 hours per in. of water.

A sprinkler system is more expensive; the man-hours of work involved can be greater, and the sprinkler itself is liable to blockages, especially where the water is being taken from a river or stream. A blocked nozzle does not necessarily stop running, but may pass a trickle of water on to a small patch of ground with detrimental results.

Modern rain-guns provide another approach to irrigation. They are particularly suitable for grassland and, in general, are more foolproof, easier to operate and the first cost is less. It is sometimes suggested that the size of the water drop from a rain-gun is so large that it damages soil structure, but the ' fall-out ' from a rain-gun is like a passing shower, coming round again in 10 minutes, during which interval the first shower has had time to soak into the ground. The average rate of delivery is an inch of water in 2½–3 hours.

Most manufacturers fit sectoring devices to their rain-guns, which enable the gun to work a corner of the field by reciprocating or to cover a semi-circle downwind in very windy conditions. If the gun is spraying only half its normal area, the application rate in inches applied per hour will be doubled, and that may be too much for some soils to absorb.

A rain-gun system tends to cover more ground with a given quantity of water per day per h.p. Perhaps the greatest advantage of a rain-gun system is the fact that it can irrigate a larger area of ground per day for a given capital investment.

Irrigation for Grass

by G. Newman (Manager, Reading University Farm)

Reading University Farm at Sonning in Berkshire stands on gravel and has an average annual rainfall of 25½ in., of which 12 in. fall between April and September. Average transpiration is 18 in., so that the average deficit is 6 in.

Experimental work has shown that

Close-up of the Farrow model 50 rain gun in action

irrigation of grass with up to 6 in. of water, with extra N fertiliser, could double the yield of dry matter. Commercial irrigation at the farm started in 1955, using the Thames as a source. A deficit of 1½ in. on this land is regarded as critical, so irrigation is started as soon as the deficit is ¾ in.

Fifty acres, a quarter of the total grassland, is normally irrigated. Early in the season this is cut for silage; later it is grazed, using 2-acre paddocks as units. The cost of irrigation works out at about £10 per acre per annum, made up of fixed cost, £2 10*s.*; running cost, £2 15*s.*; extra fertiliser, £4 15*s.*

Extra returns from irrigation are difficult to assess, but a comparison of results for 1954 and 1959 showed a one-third increase in milk sales from a herd, increased by 30% yet living on 50 acres *less* grass (see Table 1). Though 30*s.* per acre was spent on fertilisers, less concentrates were used.

Irrigation for Sugar-Beet and Potatoes

by P. J. Jones (Director, Gleadthorpe Expl. Husbandry Farm, Mansfield, Notts)

Irrigation experiments have been carried on for five years at Gleadthorpe, where the sandy soil is ideal

Table 1

Results of pasture irrigation

	Cows	*Other cattle*	*Milk sales*	*Acreage of grass*	*Concs. fed per gal. sold*
1954 ..	62	82	£7,700	250	2.8
1959 ..	81	94	£10,300	200	1.6

for measuring responses to water. The results are shown in Tables 2 and 3.

In theory, a soil should not need water until the crop it carries is transpiring vigorously, *i.e.* when it has sufficient leaf. The experimental work at Gleadthorpe suggests that irrigation of sugar-beet should start when half the planted area is covered with leaves; irrigation of potatoes should start earlier, at three-quarters emergence, probably because repeated ridging operations increase the soil's rate of drying out.

Moving equipment is expensive in labour and it is economical if 2 in. of water can be applied at a time instead of one, though allowing the deficit to build up to 2 in. reduced yields. Increased yields are not all profit – it costs money to irrigate.

Irrigation for Sugar-Beet *by A. Venables (British Sugar Corporation)*

Twelve years ago the British Sugar Corporation, in collaboration with Rothamsted, conducted a series of experiments on sugar-beet on two commercial farms at Milford, Surrey, and Kesgrave in Suffolk. The soil at Milford was a highly fertile, free-draining sandy loam; at Kesgrave, loamy sand with some gravel, more susceptible to drought than the Milford land.

Two levels of irrigation were employed, one estimated from weather data – rainfall and transpiration – the other estimated by the farmer himself.

The most spectacular results were at Milford in 1947. Irrigation increased beet yield by 9.7 tons an acre, sugar by 22.2 cwt. and gross value, at present prices, by £45 an acre. 1948, a wetter summer, saw no appreciable effect from irrigation, but in 1949 8½ in. of water increased yield by 3½ tons an acre, worth £20; 6½ in. produced a lower increase; but 13½ in. (the farmer's estimate of need) actually reduced the yield.

At Kesgrave in 1949 4 in. of water increased yield by 4 tons an acre and 5½ in. (estimated from weather data) gave 5 tons of extra yield and an extra £36 per acre. In 1950 2 in. of water (the farmer's estimate) gave a yield increase of 3 tons per acre and £23 extra income per acre.

The main results of these experiments can be summarised as follows:

(a) Sugar-beet responds extremely well to irrigation in a dry year. Maximum irrigation appears to be about 7 in.

(b) Irrigation does not necessarily depress quality; in some cases it definitely improves it.

(c) Beet tops are almost always increased by irrigation.

(d) In some cases a definite reduction in dirt tare was recorded.

Table 2
Sugar-beet responses—Yields

		No water	*Half water*	*Full water*
1955 ..	Clean beet	5.1 tons	15.1 (3½ in.)	17.7 (7 in.)
	Total sugar	18.4 cwt.	56.1	63.4
	Tops	3.5 tons	11.0	15.3
1956 ..	No treatments			
1957 ..	Clean beet	17.1 tons	16.9 (1 in.)	16.5 (1 in.)
	Total sugar	51.6 cwt.	51.0	49.6
	Tops	21.2 tons	21.5	21.6
1958 ..	Clean beet	16.2 tons	16.8 (2½ in.)	17.3 (2½ in.)
	Total sugar	50.9 cwt.	54.5	56.1
	Tops	13.4 tons	13.4	14.1
1959 ..	Clean beet	4.9 tons	18.5 (8 in.)	23.1 (10 in.)
	Total sugar	18.7 cwt.	63.8	84.9
	Tops	3.4 tons	11.4	15.4

Table 3
Main crop potatoes—Yields

	No water	*Half water*	*Full water*
1955	5.0 tons	11.8 (3 in.)	11.4 (6 in.)
1956	No water applied		
1957	8.0 tons	7.9 (1 in.)	8.5 (1 in.)
1958	8.0 tons	8.1 (2 in.)	7.4 (2 in.)
1959	7.5 tons	15.6 (7 in.)	17.6 (8 in.)

Future Developments in Irrigation
by W. Russell Farrow, B.A. (Irrigation Engineer, Farrow & Sons Ltd.)

Of the *pumps* used in irrigation schemes, over 90% are of single-stage centrifugal type; they are very flexible and useful for large quantities of water. Multi-stage centrifugal and piston pumps are less often used, though the latter are useful for high pressure and dirty water; they are less flexible. *Drive* from a tractor p.t.-o. shaft is most common, though this is basically inefficient, since it involves first reduction and then increasing gears.

Spraylines, consisting of nozzles fitted into pipes 1–2 in. in dia., apply water slowly and are costly to move. A rocking motion enables them to cover a rectangular area about 40 ft. in width, but they are not usually more than 300 ft. in length.

Rotating sprinklers, usually spaced at 30–40 ft. on a pipeline and working simultaneously, cover a width of 30–80 ft. They have small nozzles (from 0.1–0.4 in.), rotate once in 1–4 minutes and work at pressures ranging from 20–80 lb./sq. in. Commonly, 20 are required to cover 1 acre.

Rotating rain - guns have larger nozzles – from 0.4–1.5 in. – and work at pressures between 30 and 120 lb./sq. in. They rotate once in 2–10 minutes, covering a width of 80–300 ft. and an area of from ½–3 acres from one position, while applying rain at from 0.33 in. up to 0.75 in. per hour.

Of the piping used in *portable irrigation schemes*, 95% is aluminium, the remainder being made of plastic or galvanised steel. Quick-acting *couplings*, relying on internal water pressure for sealing, are commonest. Almost all pipeline systems have laterals branching from the main lines at some form of hydrant, with quickly-removable take-off points. Cast iron, asbestos cement or bitumen-protected steel are the commonest materials for *permanent pipelines*.

Pipelines are becoming lighter and handles are now available which can be snapped on for lifting and carrying. Sprinklers can now be regulated for rate of rotation and work is in progress

(*Continued on page* 148)

Coming Events

Organisers of meetings, conferences and agricultural exhibitions are invited to supply information for this regular feature. This should be received by the Editor at least three months prior to the event.

Mechanical Handling. – The Mechanical Handling Exhibition will be held at Earls Court, London, from 3–13 May. Details from the Organiser, Dorset House, Stamford Street, London, S.E.1.

Forestry. – The Forestry Commission is to hold an Exhibition and demonstration of forest machinery on the Yorkshire Agricultural Society's Show Grounds at Harrogate on 4 and 5 May. Details may be obtained from the Machinery Research Officer, Forestry Commission, 25 Savile Row, London, W.1.

Fertilisers. – The seventh General Assembly of the C.I.E.C. (International Centre of Fertilisers) will be held from 16–18 May in Lisbon, Portugal. Information may be obtained from the General Secretary, Beethovenstrasse 24, Zurich, Switzerland.

Grasslands. – The National Grassland Demonstration will be held this year on 8 and 9 June near Basingstoke, Hampshire. It will include field demonstrations of systems of silage making, using various types of forage harvester; hay making, including artificial drying; and fertiliser application. There will also be an advisory section and an exhibition of static machinery. Further particulars may be obtained from the Secretary, National Grassland Demonstration, 170 Piccadilly, London, W.1.

The 8th International Grassland Congress will be held at Reading, England, from 11–21 July, 1960. Enquiries and requests for application forms should be addressed to the Secretary, 8th International Grassland Congress, Reading, Berkshire, England.

Rural Extension. – The 8th International Meeting on Methods and Programme Planning in Agricultural and Home Economics Extension is to be held at Wageningen from 5–29 July, 1960. Further information from the Director, International Agricultural Centre, 1, Generaal Foulkesweg, Wageningen, Netherlands.

Analytical Chemistry. – A Symposium on 'Analytical Chemistry in the Service of Agriculture', organised by the Midlands Section of the Society for Analytical Chemistry, will be held at Nottingham University on 14 and 15 July, 1960. Registration forms may be obtained from Mr. C. A. Johnson, B.SC., B.PHARM., F.P.S., A.R.I.C., Standards Dept., Boots Pure Drug Co. Ltd., Station Street, Nottingham, England.

Agricultural Co-operation. – The British Council, in association with the Plunkett Foundation and the Federation of Agricultural Co-operatives of Great Britain and Ireland, is organising a course in agricultural co-operation at Cropthorne, Worcestershire, from 14–27 August. Applications should be made to the Director, British Council, 65 Davies Street, London, W.1.

Rubber Research. – An International Conference on Natural Rubber Research, sponsored by the Rubber Research Institute of Malaya, with the support of the Government of the Federation of Malaya and the Rubber Producers' Council, will take place in Kuala Lumpur from 26 September–1 October, 1960. Further information may be obtained from the Rubber Research Institute of Malaya, P.O. Box 150, Kuala Lumpur.

Brewing. – The Brewing, Bottling and Allied Trades Exhibition, formerly called the Brewers' and Allied Traders' Exhibition, will be held at Olympia, London, from 3–7 October this year. The latest developments in plant and equipment will be displayed, together with such items as heat exchangers, pumps and beer storage tanks. The Continental wine industry will also be represented this year. Enquiries to the Trades Markets and Exhibitions Ltd., 623-5 Grand Buildings, Trafalgar Square, London, W.C.2.

Corrosion. – The 1960 Exhibition will take place at Olympia, London, from Tuesday, 29 November, to Friday, 2 December. A complete range of anti-corrosion materials, methods and equipment will once again help industry to fight the menace that costs Britain £600 million a year. Bookings are now being accepted and full information is available from the Organiser, *Corrosion Technology*, Leonard Hill House, Eden Street, London, N.W.1.

Agricultural Exhibitions

South Africa. – The Rand Easter Show is to take place from 4–23 April in Johannesburg. Information from the Witwatersrand Agricultural Society, P.O. Box 4344, Johannesburg.

Germany. – An Agricultural Exhibition is to be held at Saarbrucken from 23 April–21 October. Further information from Ausstellungstechnische Leitung und Organisation Stadtverwaltung, Saarbrucken.

Cologne is to be the centre for an International Agricultural Show from 15–22 May. Enquiries to Deutsche landwirtschafts-Gesellschaft, Zimmerweg 16, Frankfurt-am-Main.

Yugoslavia. – The Novisad International Agricultural Fair this year takes place from 29 April–8 May. Details from Novosadski Sajam, Hajduk Veljkova 11, Novisad.

N. Ireland. – The 93rd Ulster Agricultural Show is to take place from 25–28 May. Further information may be obtained from the Royal Ulster Agricultural Society, King's Hall, Balmoral, Belfast.

New Zealand. – The Waikato Agricultural Winter Show will be held from 31 May–7 June. Details from Waikato Show Association, P.O. Box 616, Hamilton.

England. – The Bath and West Show will be held from 1–4 June. Information from the Bath and West and Southern Counties Agricultural Society, 3 Pierrepoint Street, Bath, Somerset.

This year's Royal Show will be held at Cambridge from 5–8 July. Details may be obtained from the Secretary, Royal Agricultural Society of England, 35 Belgrave Square, London, S.W.1.

The Great Yorkshire Agricultural Show takes place in Harrogate from 12–14 July. Information from the Yorkshire Agricultural Society, Cliftonfield, Shipton Road, York.

Manuring of Crops in the Far East

H. L. RICHARDSON, D.I.C., M.SC., PH.D.*

The author has previously dealt with the requirements of cereal crops, oil-bearing crops, fibre crops and fruits. Here he goes on to deal with the requirements of beverage crops and other major crops.

5—Beverage Crops

Tea. Tea is, of course, the main beverage crop in Asia and it is widely distributed, the areas of principal production being in China, India, Ceylon, Formosa, Japan, Indonesia and Pakistan. Most of the tea grown in China and Japan is consumed within each country. The total area of tea in the Far East is over 2 million acres and the crop provides an outlet for considerable amounts of fertiliser, because it is heavily manured in most countries where it is grown.

Until recent years tea was regarded as a crop that needed mainly nitrogen in the form of sulphate of ammonia and on some soils no other fertiliser was used. This was confirmed by the results of field experiments. Then, both in the experiments and in the tea gardens, symptoms of potash deficiency began to appear, and on most soils the crop now receives both nitrogen and potash, or else a complete fertiliser.

Heavy applications of nitrogen by the standards of some Far Eastern countries – 80 lb. N per acre or more – are generally used for tea, along with a similar amount of potash and phosphate according to the needs of the local soils. In some of the countries growing tea for export, the crop is probably receiving about its optimum fertiliser application already and the consumption may not increase much further, but in others, notably China – where little chemical fertiliser is yet used on tea – quite large increases in fertiliser consumption should be possible.

Coffee. This is mainly grown in plantations in Indonesia and southern India, but the total area is small, and so is the fertiliser consumption.

Loading sugar-cane in an Indian field

6—Other Major Crops

Sugar-cane. The Far East is a large producer of cane sugar, but this is mostly consumed domestically, so that – except for Taiwan, which supplies Japan, and the Philippines – relatively little finds its way on to the world market. Although full statistics are not available for the area of sugar-cane planted in the Far East, the figure approaches 10 million acres with China included. Because of the economic value of the crop and its large responses to fertilisers, it was one of the first to receive intensive manuring in those countries where it is grown.

Sugar-cane is a grass and, like the cereals, it responds well to nitrogen, very heavy rates of application being profitable where the crop is irrigated. It frequently requires potash in addition to nitrogen, partly because sugar-cane tends to be grown on loamy or sandy soils rather than heavy clays, and partly because high carbohydrate production is the aim. Phosphate is sometimes applied, although this may be done more on a basis of maintaining the fertility of the soil than because direct effects on yield or quality have been demonstrated.

Beyond these general rules, the use of fertilisers with sugar-cane differs too much from place to place to be discussed here. Sugar-cane now consumes a considerable proportion of the fertilisers used in the Far East, and this consumption is likely to go on increasing, although to a lesser degree than that of rice because the area of sugar-cane is so much smaller.

Tobacco. Although tobacco is exported in quantity only from Indonesia, most countries in the Far East grow considerable amounts for home consumption, particularly China and India. The total area of the crop is estimated at nearly 3 million acres, but there is probably a great deal of home-grown tobacco, including the strongly-flavoured *rustica* species, that does not appear in official returns.

The use of fertilisers varies greatly from country to country – much of the home-grown crop receives only local manures, if any – but the commercial crop is sometimes very heavily fertilised with nitrogen or complete mixtures. With more attention to the

* Imperial Chemical Industries Ltd.

Replanting rubber: in the background are old trees killed by poisoning; in the left foreground are young clonal (improved) trees. When replanted, rubber is given a complete fertiliser mixture, in which magnesium may be included

production of high-quality tobacco in future, the consumption of fertilisers will probably increase, although there may be more emphasis on potash and less on nitrogen.

Rubber. This is *par excellence* a crop of the tropical Far East, mainly Malaya and Indonesia, although it is also quite widely grown in Ceylon, Siam and other territories. The total area is not reported, but is probably well over 5 million acres. The manuring of rubber has been thoroughly studied in long-term field experiments and, although there are, of course, variations from place to place, the general principles are clear.

On forest soils planted for the first time young rubber plants often require only nitrogen and phosphate, although mixtures containing a little potash and magnesium are used if there is any reason to suspect that these elements may be lacking. Rubber appears rather sensitive to magnesium deficiency, which produces conspicuous leaf symptoms. With replanted rubber and high-yielding clones a deficiency of potash and/or magnesium is quite likely to occur and complete NPK mixtures, with or without magnesium, are widely used on young rubber.

Mature rubber, with its extensive root zone, can obtain from the soil most of the mineral nutrients it needs, and nitrogen is its main requirement. Straight nitrogen fertilisers are generally employed for mature rubber, although some phosphate, potash and/or magnesium fertilisers may also be applied on very sandy soils, or if the condition of the mature trees suggests that a deficiency of some mineral nutrient is developing.

It is mainly the large plantations that manure rubber trees, and even here the manuring may be withheld if the price of rubber falls; smallholders have used little fertiliser in the past, but are now being encouraged to do so. The new, heavy-yielding clonal varieties are likely to benefit from heavier fertiliser applications than the old seedling varieties. The consumption of fertilisers by rubber could therefore be further expanded, although prospects are limited by some uncertainty about the long-term effects of competition with synthetic rubber.

(*To be continued*)

Latex flowing from a mature rubber tree. Such trees usually receive nitrogenous fertilisers only

Cambridge Irrigation Conference

(*Continued from page 145*)

on a sectoring device – which rain-guns already have – to make them available for work in all wind conditions.

Work is now concentrated towards reducing the labour needed to move irrigation systems. Among alternative ideas are skids or wheels to aid pipeline towing, large boom-type spray-guns which can cover a field from one or two positions, and rain - guns mounted on trailers, tractors or even floating platforms.

The ultimate answer may be a multi-sprinkler scheme with all equipment permanently in position and multi-purpose irrigation capable of performing the following functions: ordinary water irrigation; organic irrigation, taking animal solids and urine; fertiliser application by injecting nutrients into water; pest control without chemicals by using frequent watering from multi-sprinkler schemes; and multi-sprinkler schemes for frost protection.

Pakistan's Tea Industry

In the February issue, on page 51, it was stated that the total acreage under tea in Pakistan is at present 75 million acres. The correct figure should have been given as 75,000 acres.

Synthetic v. Natural Rubber

AN analysis of rubber consumption and production over the next decade indicates that natural rubber production will level off at approximately two million long tons per year, but according to economists; rising standards of living and increasing population will boost world rubber consumption to seven million long tons by 1970.

This gap between consumption and natural rubber production must be filled with synthetic rubber. Production of synthetic will probably more than double during this period.

In 1955, 58.5% of the total rubber consumed in the U.S.A. was synthetic. Last year, to supply more and better products for ever-expanding markets, the U.S. consumption of synthetic rubber jumped to 66%.

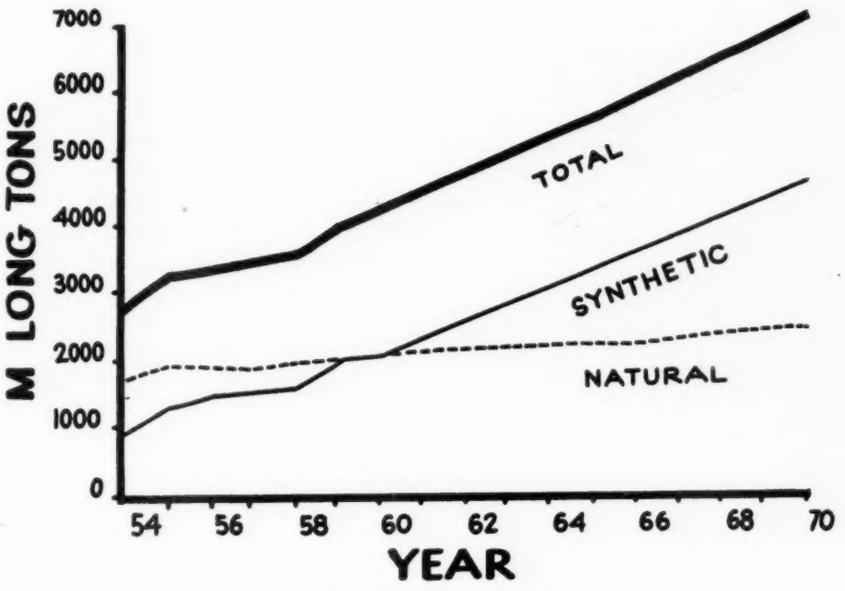
The Firestone Tyre and Rubber Co., one of the world's largest producers of rubber, plans to continue its expansion of both natural and synthetic rubber production facilities, according to Raymond C. Firestone, president of the company.

The company has developed two new synthetic products which could make the U.S.A. completely independent of natural rubber if necessary.

Synthetic rubber

Their plants at Lake Charles, La., and Akron, Ohio, have increased their production capacities to 230,000 long tons of styrene-butadiene type rubbers per year. These have proved superior to natural rubber for ordinary car tyres, but natural rubber, or its equivalent synthetic, prove most effective in heavy-duty lorry, tractor or aircraft tyres. To meet this need, Firestone scientists have developed two new synthetics – 'Coral' and 'Diene' – during the past 10 years.

Coral rubber, developed in 1954, duplicates the molecular structure and is a complete replacement for natural rubber. This has been one of the major goals of rubber research for many years. Lorry tyres made of this new synthetic have met or exceeded all military requirements. Thus the U.S.A. need no longer be dependent on imported natural rubber in an emergency.



World Rubber Consumption

Diene, developed by Firestone research men in 1958, is a rubber extender. Tests show it has improved crack resistance, satisfactory running temperatures and greatly improved skid resistance. It can be used to supplement a large portion of the natural rubber in tyre manufacture.

Natural rubber

Firestone, which started its 90,000-acre rubber plantations in Liberia in 1924, has started new plantations in Brazil, Guatemala and the Philippines. In addition, an extensive replanting programme, designed to replace older trees with high-yielding stock, is nearing completion on the old Liberian plantations. Firestone last year produced 84 million lb. of rubber from its plantations in Liberia.

Other American interests have now started plantations to help protect the vital supplies of natural rubber, but rubber trees require seven to eight years to reach tapping age. It will be that long, in most instances, before the effect of new plantings will be felt in the world rubber market. These plantations, then, will only partially fulfil the demand for rubber which will be created in the next ten years.

Canned Citrus in Nigeria

Plans to enter the U.K.'s canned citrus fruit market have been announced in Ibadan by the Western Nigerian Development Corporation.

The Corporation's five-year-old £317,000 Lafia canning factory is capable of turning out 200,000 tons of canned goods each year. So far the factory has confined itself to the canning of oranges, lemons, grapefruits and pineapples. Future plans include the processing of other tropical fruits native to this region.

Commercial citrus planting in Western Nigeria is a relatively new development which was introduced to provide an alternative cash crop for farmers whose cocoa plants were ravaged by 'swollen shoot' disease. In order to maintain a constant supply of citrus fruit for processing, the Western Nigerian Ministry of Agriculture and Natural Resources, in partnership with local farmers, is planting hundreds of acres of land with citrus trees.

New Publications

Profits and Fertilisers

Fertilisers and Profitable Farming. By Dr. G. W. Cooke. Pp. 122. Crosby, Lockwood, London. 1960. Price 15*s*.

This is an admirably concise book devoted to the important and practical subject, fertiliser use, covering the selection and the amounts per acre, correct timing and the best methods of application.

It confines itself, however, to British conditions, though overseas readers may well find it interesting and stimulating, particularly in countries where fertiliser practice is less advanced than in Western Europe. For the British farmers at whom the book is aimed it is a timely and much-needed contribution.

The large expansion in British fertiliser consumption since 1940 has not been only a quantitative development. Placement of dressings has also been introduced, especially with cereals; new crop varieties, more responsive to nitrogen, have replaced some of the once famous varieties; and crop rotational systems have been revolutionised. Some of the arable crop recommendations in this book could not have been put forward even five or 10 years ago with the authority they now possess.

The author – a senior officer of Rothamsted – has played a leading part in the scientific study of fertiliser practice in Britain during the last 10 to 15 years. He has resisted the temptation to write a more detailed and formidable book, realising that the practical farmer very often has limited digestion for pages of print. He has not, however, over-simplified his recommendations and the main kinds of adjustment – for soil type, for climatic differences or because of previous crop effects or the complementary use of F.Y.M. – are all covered.

The book requires intelligent use – indeed, any book on this subject, that did not, would be a suspiciously spurious contribution. Too many people in the past have gullibly believed in sweeping generalisations about fertiliser use. Britain, with its climatic variations and assortment of soil types, is probably one of the world's outstanding examples of the need for flexibility in fertiliser use.

Overseas readers should not assume that the standard rates recommended by Dr. Cooke (as bases for circumstantial adjustment) are as yet widely used in British farming. For arable crops these rates are used only on the best farms, and in some areas such farms are still quite exceptional. As surveys have shown, smaller rates are used on most farms and only sugar-beet is a generally well-fertilised crop.

Fertiliser use on grassland is less fully treated, but Dr. Cooke's chapter on this more complex subject is an admirable blueprint for a revolution in British grassland fertiliser treatment during the 1960s.

This is an excellent book, but its effectiveness must depend upon the extent to which it is read by farmers, particularly those who are small users of fertilisers.

D. P. HOPKINS

Genetics and Cotton

The Application of Genetics to Cotton Improvement by Sir Joseph Hutchinson. Pp. 83. Cambridge University Press, London. 1959. Price 15*s*.

The publication in 1947 of 'The Evolution of *Gossypium*' (Hutchinson, Silow and Stephens) established cotton as a classical example of a crop in which modern breeding programmes are based on knowledge of the evolution of the cultigen and of related species. Twelve years later Sir Joseph Hutchinson has reconsidered the evolution of *Gossypium* and its bearing on the progress, problems and prospects of cotton breeding. This new work shows how modern improvement of the crop represents a consciously directed continuation of the evolution of the cultivated species; breeding has become the management of evolution.

The book falls into two sections. In the first the pattern of the evolution of *Gossypium* is presented in terms of the origin, distribution and isolation of variability. The association between variability, selective forces and population sizes in cultivation and the relationship of the distribution of variability to the breeding system are discussed with continual emphasis on the decisive role of man. The influence of Vavilov's thought is evident, but it is Vavilov brought up to date.

The origin of the diploid, Asiatic cultivated cottons is thought to lie in Africa, *G. herbaceum* race *africanum* being the modern representative of the ancestral stock. The problem of the source of the Asiatic (or African?) genome in the South American tetraploid cottons is left open; Sir Joseph still favours the theory of a trans-Pacific migration, but the other possibilities are outlined. The Pacific provides a number of similar problems in crop migration. It is an ocean whose island inhabitants have been long-distance sea travellers for many generations, but fuller information on the climate of Alaska and the Behring Straits in Boreal times may make it easier to consider a land rather than a sea migration.

The second section, the final third of the book, is a highly condensed discussion of the breeding methods which are currently in use for the improvement of cotton and of the ecological and physiological problems which arise in the definition of breeding objectives. One recent advance in plant breeding is the realisation of the need for clear physiological as well as genetical definition of the characters. The discussion could usefully have included comparisons with the methods which are used in other crops. The important selection index technique is clearly presented, but without the detail used in earlier chapters.

This valuable book will provide interest and stimulus to all who are interested in the botany of crop plants. The text is lucid and elegant. It has a single fault: it is too short.

J. K. JONES

Cockle Park Farm

By H. C. Pawson. Pp. 261. Published for the University of Durham by Oxford University Press. 1959. Price 35*s*.

In bringing together into a single volume the details and results of 60 years' work at Cockle Park Experiment Station in Northumberland, Professor Pawson has had to steer a fine course between a purely historical discussion of the development of the farm by the succession of people who have worked there and a compilation of unreadable

lists of treatments and results. Detail must be included for the reader's own appraisal of the work and a description is required of the contemporary agricultural background which largely determined the problems investigated.

The book is a coherent and readable summary of all the investigations during this period, yet it contains sufficient detail to make it a standard reference. Only the chapters on crop rotations and arable crops err on the side of excessive detail in the script.

Viewed in the light of present-day systems of agricultural experimentation, one gains the impression that the years towards the end of this book mark the close of an epoch. The large-scale plot, represented once only in an experiment, is now largely of historical interest and it is questionable whether the classical trials on Tree Field, Hanging Leaves and Palace Leas can be regarded as more than demonstrations. The book clearly shows, however, that the impact of the results on farmers was considerably greater than could be claimed for many more sophisticated experiments in recent times. Rapid results are demanded by the urgent present and replication in space helps to soothe misgivings about lack of replication in time. One is, therefore, all the more impressed by the pertinacity of those who have measured results from trials covering more than half a century.

R. C. ANSLOW

Recent Russian Publications

The past few years have witnessed a steady expansion of British-Soviet contacts in the fields of science, technology and culture. The Soviet Book Exhibition, held in London in February and sponsored by the Ministry of Culture of the U.S.S.R., followed an analogous exhibition, organised in Moscow by the British Council in the autumn of 1959.

The following is a selection from some 60 books in Russian in the section on agriculture:

Combine-Operator's Reference Book by N. Avdeyev, V. Korobov, V. Solovyov, 1958.

Land Reclamation and Afforestation, 1956.

Tobacco Growing by A. Buchinsky, V. Volodarsky and P. Asmeyev, 1959.

Millet, Biology, Selection and Agrotechnics by E. Varenitsa, 1958.

U.S.S.R. Agriculture in 1959–65 by P. Dorosehenko, 1959.

Varieties and Hybrids of Maize by M. Kalinin, 1958.

Grafting of Fruit Trees by M. Klements, 1959.

Organisation of Fodder Production, 1959.

Plant Growing, 1959.

Red Clover Crops by P. Sergeyev and others, 1958.

Plant Growing Textbook for Agricultural Schools by A. Smirnov, 1958.

Chemistry in Agriculture, 1959.

Grain Farming in 7-Year Plan Period by I. Khoroshilov, 1959.

Reference Books

Agricultural Insects of East Africa, compiled by R. H. Le Pelley. Containing a list of East African plant-feeding insects and mites, with their host plants, their parasites and predators, giving distribution by territories and references to the literature, together with lists of stored products insects and introduced insects, mainly covering the period 1908–56. Published by the East African High Commission, Nairobi, Kenya. 1959. Price 42*s*.

Hanna's Handbook of Agricultural Chemicals, by Lester W. Hanna. Second edition, 1958. Pp. 450. Descriptions are given of over 1,000 commercial chemicals and materials used in agriculture, forestry and horticulture, together with their common and chemical names. There are also sections on toxicities and antidotes, emergency treatments and first aid, U.S.D.A. pesticide regulations, Food and Drug Administration residue tolerances, and safety practices. A valuable book of reference, which is obtainable from the author, Route 1, Box 210, Forest Grove, Oregon, U.S.A. Price $5.95.

Where to Buy Everything for Agriculture and Horticulture. A trade index to the principal sources of supply in Britain of farm and horticultural requisites, implements, machinery, chemicals, feeding stuffs, fertilisers, plants, trees, seeds and sundries. Pp. 155. Obtainable from 'Where to Buy' Ltd., John Adam House, 17–19 John Adam Street, Adelphi, London, W.C.2. Price 5*s*.

British Tractors and Farm Machinery. The Green Book, Summer Edition, 1959. Details are given of new workshop developments, new engines, irrigation equipment, instruments and tractor accessories, earth-moving, trenching and ditching equipment and N.I.A.E. tractor and implement tests. Obtainable by annual subscription only from Norman Kark Publications Ltd., 77 Brook Street, London, W.1.

N.I.A.B.

A new leaflet recently issued by the National Institute of Agricultural Botany at Cambridge includes much helpful advice for herbage seed growers. Entitled 'Harvesting and Threshing Grass and Clover Seed', it is No. 4 in a new series of Herbage Seed Growers' leaflets.

Revised leaflets describing varieties of fodder beet and mangel and of swedes are now available from the N.I.A.B. In each of these crops the Institute has tested very large numbers of varieties and the leaflets describe the important root characters, the size of top and percentage bolters of the varieties which have proved most successful in the trials. These leaflets, 'Varieties of Fodder Beets and Mangels' (Farmers Leaflet No. 6) and 'Varieties of Swedes' (Farmers Leaflet No. 7), give the farmer the information he needs to make an intelligent choice from the bewildering range available.

Copies of these three pamphlets may be obtained from the Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

U.S.D.A.

'Guide to Intensive Coffee Culture' Pp. 51. illus. From U.S. Govt. Printing Office, Washington D.C. Price 25 cents.

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THE WORLD'S LEADING NAME IN SPRINKLER IRRIGATION

In over fifty countries Wright Rain overhead sprinkler irrigation has brought plenty and prosperity. Backed by years of experience and technical research complete WRIGHT RAIN PLANNED IRRIGATION schemes are "tailored" to suit all farming conditions.

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Wright Rain Major Sprinklers working in sugar cane in Mauritius. In all countries of the world leading cane growers are turning more and more to Overhead Irrigation to secure maximum yields of high class cane.

Sweden: Wright ' Rain ' installation working on grassland near Vasteras. Outstanding results were obtained during the exceptionally dry summer and autumn of 1959

Machinery and Equipment

Irrigation Pays

All plants need water to grow. The need is, of course, greatest in hot and dry conditions, when the soil is likely to be short of the water needed for transpiration and plant growth.

Irrigation prevents these shortages in soil moisture from becoming serious and, properly applied, can secure for farmers and growers, and for estate and forest nurseries, maximum growth without any check during spells of dry weather.

Irrigation not only gives heavier yields, but also better quality – and earlier harvesting with early marketing.

Grass, one of the most rewarding crops to irrigate, can be increased four-fold; potato yields can be doubled; increases of sugar-beet of between 30% and 40% are normal; irrigated runner beans can yield more than 12 tons to the acre, and top fruit and soft fruit yields can similarly be increased by irrigation. It has been estimated that the profits from vegetable growing can be increased by as much as £100 per acre.

Granular Applications

One method of overcoming the drift problem is by the use of herbicides in granular form, in which the hormone is mounted on a ' carrier ' to give it bulk; similarly, one way of ensuring that the whole of an applied plant food reaches the roots, without being wasted on the leaves and possibly scorching them, is by using granular fertilisers.

Holland: a Wright ' Rain ' installation working in a market garden near Breda, where growers use overhead irrigation to protect their early crops and fruit trees against front damage

Such applications can be made from the air or by means of a tractor-mounted distributor; the granular material may also be thrown by hand, but this method involves some risk of dermatitis or other ill effects. The *Williams* granule thrower, seen in its prototype form, is a simple, light and inexpensive device which imitates the operation of spreading by hand, but without the material being touched.

The applicator consists of a conical hopper, a flow-regulating device with a manually-operated lever arm and a corrugated rubber throwing tube, from which the granules are ejected by centrifugal force, in a series of arcs, a distance of 6 ft. and clear of the man. The operator can carry the machine either in front or on his back and he operates the lever arm in time with his stride; in this way the material is spread uniformly. The rate of application – from 6–16 cwt. per acre – is determined by fitting any one of a set of feed control plates. When the actuating lever is not operated the flow of granules stops.

The inventor states that he has used it successfully for spreading fine, granular borax, *Shell* dieldrin, *Fison's* ' Growmore ' fertiliser and granulated copper sulphate crystals.

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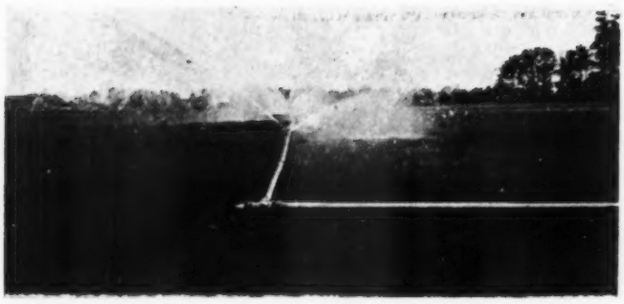


Left: '880' *rainers by British Overhead Irrigation Ltd., operating on a 4 in. sprinkler line; it is fed by the 5 in. main line which can be seen in the foreground. As many as 8 rainers can be worked simultaneously if required, covering a total area of about 5 acres.*
Right: '856 *G2*' *sprinklers by B.O.I.L., (with a sprinkler line of 700 ft.), covering an acre of brussels sprouts*

Correcting Wheel Spin

One of the difficulties confronting tractor operators is the avoidance of wheel spin when operating over marshy or waterlogged ground. To overcome this difficulty the *Nuffield Organisation* have developed a differential lock which can be fitted at a small cost as an optional extra to their current production tractors, both Nuffield 'Three' and 'Four'.

The object of the lock is to isolate the differential gear in the rear axle, thus producing a rigid axle, so that when operating in soft wet conditions wheel spin on one side can be counteracted by the adhesion of the wheel which is not spinning.

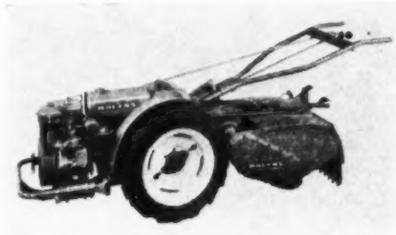
The unit is simple to operate, a foot pedal being depressed to secure the lock; normal differential operation is automatically restored immediately the operator removes his foot from the pedal.

A Heavy-duty Rotary Tiller

After several years of research and testing under field conditions, a new heavy-duty rotary tiller has been announced by Bolens Products Division of the Food Machinery and Chemical Corporation, U.S.A.

Features of the Model No. 80 heavy-duty rotary tiller include: heavy frame; automotive-type 2-speed wheel transmission and rotor drive assembly; equal distribution of weight and low centre of gravity; automotive-type differential for ease of steering and turning; and improved location of the controls for fast, easy, positive handling under all operating conditions.

The machine provides high and low rotor speeds and the 2-speed transmission assures a proper correlation between rotor and travel speeds. The high speed is for eradicating weeds, excessive runner growth of strawberries and sucker growth of raspberries; the low travel speed is for tilling. The full 20-in. side-drive rotor assembly is made up of 10 ploughshare hardened steel tines, capable of performing heavy soil operations because of their self-sharpening, non-winding, slicing and blending action. A safety slip clutch protects the transmission from excessive rotor shock loads. The full



The tremendous power of the new Bolens heavy-duty rotary tiller necessitates ruggedness and durability, while maintaining manoeuvrability and ease of operation

18-in. diameter of the rotor assembly, in combination with the easily adjusted depth control, permits tilling at selective depths of from 0 to 9 in.

Forage Harvesting

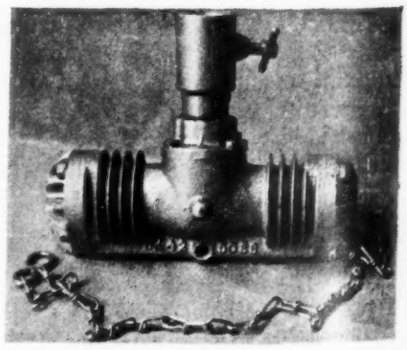
The 'Taarup' forage harvester, which is marketed by the *Western Machinery & Equipment Co. Ltd.*, was one of the machines which gave a good performance in the difficult green crop harvesting competition recently organised by the Royal Agricultural Society of England in Sussex. It will cut all silage crops – grass, lucerne, clover, peas, beet tops, vetches and, by using a special attachment, kale, and it can also be used to pick up and shred straw, potato haulm, napier grass, sun hemp, cotton stems from the swath.

The machine is offered in three models – two are offset and one is in-line. The tractor, forage harvester and the trailer work together as one unit to cut, to chop, to lacerate and to load the material in one continuous operation. The spouts can deliver either to the side or to the rear, and there is also a special extension tube which can be used to advantage in windy weather.

Tractor Air Pump

A small double-acting compressor actuated by the p.t.-o. is offered by *Benedict (Agricultural) Ltd.* for inflating the tyres of tractors and other agricultural vehicles. The compressor socket is simply pushed over the end of the p.t.-o. shaft and fixed by the screw; the body of the compressor is held by a chain, whilst the impeller shaft is free to turn within the compressor. A 16-ft. air hose is supplied and this enables the rear tyres of a trailer to be inflated without uncoupling.

This simple and inexpensive device will save time, tyre wear and tyres, particularly in the tropics, where hand pumping is hot and tiresome work, and



The 'Benedict' air pump has a 16-ft. air-line which is screwed into the hole seen by the number plate

in consequence machines may be run for short distances on flat tyres. One such incident will thus cost more than the price of three of these mechanical tyre inflators.

Submersible Pumps

An under-water motor which is completely sealed with an oil seal so as to exclude sand has just been announced by *Sumo Pumps Ltd.* These new ' Clam-Seal ' motors, which were originally developed for use in Texas to prevent the abrasive effects of hard and sandy waters, are now being fitted to their range of submersible pumps.

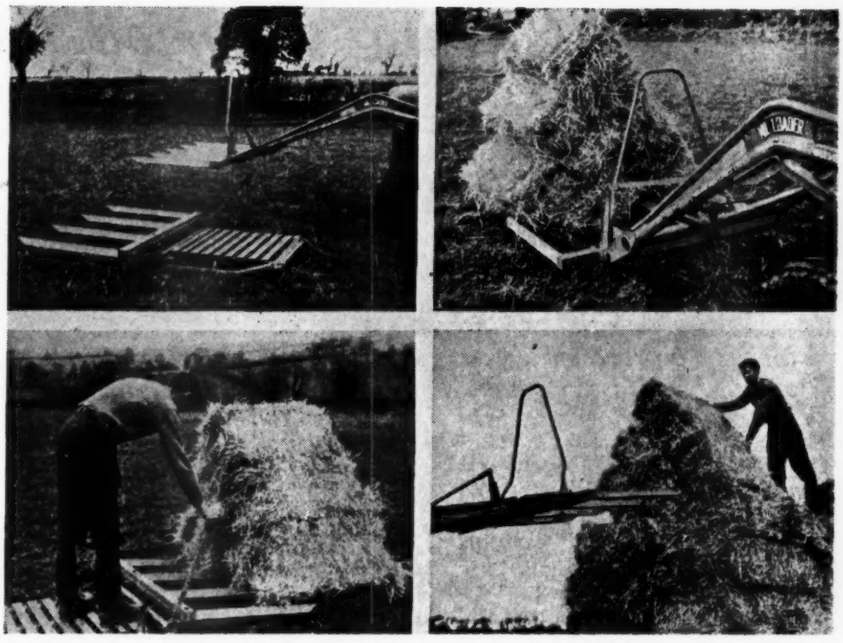
Mono-wheel Boom Sprayer

Here is a machine for the small grower for all kinds of crop spraying, for the treatment of nursery beds, for tobacco, for pineapples and for similar row crops grown on a comparatively small scale, particularly where the farmer does not possess a tractor or

The Allman ' Mono-wheel ' boom sprayer begins to spray as soon as the machine is pushed forward

the going is difficult. It would also appear to be a useful implement to have on field research stations, where a large number of small plots may require individual treatments with liquid fertilisers, weedkillers, fungicides and insecticides.

This useful little machine, offered by *E. Allman & Co. Ltd.*, consists essentially of a bicycle wheel, which serves both as a carrier and a source of power; a 6-gal. spray tank; and a six-jet spray boom, which is adjustable for height to suit the crop. The wheel is fitted with a crank which operates the pump which delivers the spray liquid to the spray boom, a constant pressure being maintained by means of a pressure cylinder. Spraying starts when the machine moves forward and stops when the operator ceases to advance.



Top left: *Equipment showing ' Diamond ' sledge (six-bale) complete and pick-up fork (10-bale) attached to hydraulic loader*

Bottom left: *Six-bale stack being dropped by the simple control level action*

Top right: *Pick-up fork being located beneath six-bale stack ready for lifting*

Bottom right: *Tractor withdrawing after depositing stack of six bales on trailer*

Dual-Purpose Bale Sledge

The ' Diamond ' bale-loading unit, manufactured by *Curlight Industries Ltd.*, consists of a working platform mounted on a sledge, a pick-up fork and a fore-end loader attachment. They are produced in two sizes, with forks to take six or 10 bales. As the sledge is towed behind the pick-up baler, the operator stands on the slatted platform and lifts each bale ejected from the baler on to the pick-up fork.

He lays the first bale lengthwise on one edge between two tines and so builds up a solid stack of six or 10 bales (according to the number of tines). The completed triangular stack of interlocked bales is lowered to the ground by means of a control lever and it is left to be collected later, while the baling machine and the following sledge go on to make more bales and more stacks.

When the whole field has been done the fork is detached from the sledge and in one minute is attached to the fore-end loader attachment by means of the usual connecting pins.

The unit is then ready to lift a triangulated stack of bales bodily, transport it to the trailer and deposit it therein. The interlocking of the bales in the stacks makes it possible for the loader to travel at high speeds. While another man arranges the bales neatly, the tractor driver is free to return for another load.

Those who have experience of bale handling can appreciate the advantages of a system in which the bales do not have to be manhandled. With only two men, more than 250 bales an hour can be loaded on to trailers. The locked diamond formation of the stacks ensures firm standing with only a small surface in contact with the damp ground; the triangulated shape acts as a roof, giving excellent weather protection, air can pass freely under the stack, and the points of the loader fork can be smoothly introduced into the spaces between the bottom tier of bales.

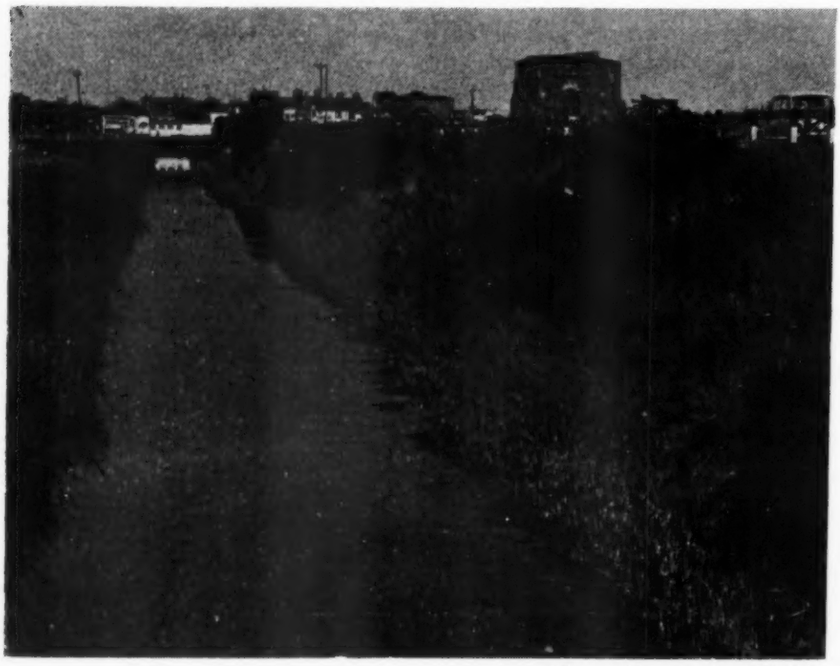
Cleaning Choked Channels

Romney Marsh in Kent is protected by a sea wall, of great thickness, from inundation at high tide. At low tide the speedy release of any accumulated flood waters is essential if the land is not to become useless swamp. This is important, as the area affords pasturage for vast flocks of sheep.

The old method of reed control as practised on Romney Marsh in Kent. The reeds have to be cut every year

RIVER conservancy boards, drainage and irrigation boards and canal navigation authorities, and also farms, estates and plantations requiring to be irrigated and drained are generally faced with the problem of keeping fresh-water canals and drainage channels free of weeds, which can effectively obstruct the free flow of water and, in the case of agricultural lands, can raise the water table and so cause serious waterlogging. Clearing these weeds is always a heavy item of expenditure and in Britain alone the annual expenditure amounts to several million pounds.

Mechanical excavators and ditch cleaners are sometimes used where a deposit of silt has also to be removed. In deeper channels small launches fitted with knives can also be used for reed clearance, but in the main it is the man in rubber thigh boots, armed with a two-handed scythe, who does this laborious work. The cost of such manual operations ranges from £40–£80 per mile; wages of agricultural workers are rising, while labour in the rural areas of Britain is becoming scarcer. Obviously chemical control – if effective – could save a considerable amount of money.



Photos: Dow Agrochemicals Ltd.

The new method of reed control. The dead reeds on the right were sprayed with 30 lb. of 'Dowpon' per acre. Those on the left were untreated

In Romney Marshes

Recently the Kent Rivers Board carried out some very successful experiments with a systemic reed-killer in the Romney Marshes, where there are over 70 miles of watercourses, ranging from 35-ft. canals to lesser ditches up to 12 ft. in width, all drainage being by tidal outfall to the sea. The free flow of water in this complicated system must be maintained, but it is an expensive business, for the annual bill for care and maintenance of the channels is about £10,000, and as many as 35 men may be employed in reed cutting.

The main problem is the common reed, *Phragmites communis*, which may reach a height of 10 ft., together with reedmace, *Typha*, and the soft rush, *Juncus articulata*. These reeds are

capable of choking any channel if it is neglected for more than a year; good drainage is essential if the pastures in this highly fertile, low-lying area are not to degenerate.

Chemical reed control

Three trials have been carried out on stretches of watercourse at Dymchurch and near New Romney, where the reeds were rapidly closing the channels. The chemical used was 'Dowpon', which is a formulation of dalapon, now being marketed in the U.K. by *Dow Agrochemicals Ltd.* The dosage rates ranged from 20–40 lb. of the chemical per acre, and it was found that one man, using a knapsack sprayer, was able to spray 48 chains in two days on the three widely separated sites.

All the reeds had died back 23 days later and the absence of any regrowth during a summer which favoured rapid reed growth showed the effectiveness of the treatment. The dead reeds remain standing and obviously, if they have to be cut and raked out, nothing will be saved; if they are allowed to decay, this will absorb too much oxygen from the soil and the water; and if they fall back into the water and block the channel, the whole purpose of the operation would be defeated. The solution is to set fire to the dead reeds, using a little paraffin to start the conflagration.

The cost of chemical reed control was found to be about £36 10*s*. per mile – £28 6*s*. for materials and £8 4*s*. for labour – which is less than the lowest cost by manual operations.

These trials had to be carried out by knapsack sprayers because of the network of canals, drains and ditches in the area, which make it difficult for a tractor - mounted sprayer to move freely. Other possible methods are to use boom sprayers of suitable design and, where the channels are deep, to mount power sprayers on boats.

One of the obvious problems of reed control using chemicals is the effect on fish and game. The authorities took samples of water from stretches which had been sprayed with 'Dowpon' at the rate of 300 parts per million, which is much higher than is necessary for reed spraying, and they placed fish in cages in these over-sprayed channels. It was found that the fish were unaffected. 'Dowpon' is non-toxic at the recommended dosages.

Agricultural Chemicals and Supplies

Plant Improvement

Though there are instances of cultivated plants which appear never to revert to their original wild state, generally what man has improved upon can, through inattention and neglect, quickly revert in a few generations.

Single plant selection is an important and effective practice of the House of Clucas, now celebrating its centenary. Outstanding plants are selected and recorded and these are isolated, planted and replanted in successive generations until a new foundation stock of flowers or vegetables has been created.

Another method of improvement practised by *J. L. Clucas Ltd.* is by hybridisation, which is becoming increasingly important in the development of desirable qualities – appearance, flavour, maturity, growing period and yield. In this method single plant selections are inbred by self-pollination for a number of generations and eventually the selected lines are cross-pollinated. The resulting hybrids often prove to be of exceptional vigour, combined with uniform habit.

Prior to sowing for the large-scale production of seed, pedigree foundation stock seeds are tested in home and overseas gardens to give the special climatic and environmental conditions for each type of seed.

Before the seed is distributed to market gardeners and retailers samples are taken from each lot of seed for testing — firstly by close scrutiny and separation counts; then germination tests follow, varying from a few days to a month or so.

Preparing market garden seed orders in the Clucas despatch department

Ornamental and Vegetable Seeds

In 1876 *W. Atlee Burpee* started in business as seedsman in Philadelphia. In 1888 he opened up a testing station at Fordhook Farms in Pennsylvania, before the U.S. Government had any experiment stations at all. In 1909 he started Floradale Farms in California.

At first it was mostly a matter of discovering outstanding varieties of vegetables and flowers; now he also creates new varieties of hybrids by modern methods of plant breeding.

The first hybrid vegetable seeds produced in America, such as tomatoes, cucumbers, eggplant and the Cantaloupe melon, were the product of research at Fordhook. Burpee is also claimed to be the first seedsman to produce hybrid petunias, marigolds and zinnias; the first tetraploid flowers, too, came from the Floradale Farms.

Grasses and Clover Seed

The *Rudy-Patrick Seed Co.*, of U.S.A., are specialists in the production of selected and hybrid varieties of grasses, clovers, alfalfa and other fodder crops. Their catalogue lists no less than 31 varieties of clover, 28 of alfalfa and 66 varieties of grasses.

Dangers from Chemicals

The use of chemicals has become an accepted method of protecting crops and foodstuffs from pests and diseases and each year sees an increase in the world use of agricultural chemicals. To be effective all pesticides need to be toxic to some form of life, and so some of those used may present some inherent risk to human life and health.

It is the duty of the industry manufacturing such products for agricultural, industrial and domestic use to carry out research to assess the risks involved; to publicise correct handling methods which will enable them to be used with safety; and to carry on the search for new products, so as to replace toxic chemicals with others which will offer less risk to human and animal life.

'Safety in the Use of Insecticides' is the title of a brochure which has just been produced by *Fisons Pest Control Ltd.* It discusses the dangers arising from the use of toxic chemicals, the hazards of commercial insecticides, the symptoms of over-exposure to toxic materials, first-aid treatment and the problems of pesticide residues in human and animal foodstuffs. It ends with a summary of the U.K. regulations on the handling of toxic chemicals and a useful list of references.

Coffee Pest and Diseases

Successful coffee growing is partly dependent on effective pest and disease control. When trouble arises it is important that the grower should be able to recognise the symptoms, identify accurately their cause, and be in a position to take prompt and effective measures to ensure control.

Aldrin, dieldrin and endrin are chlorinated hydrocarbon insecticides, which are highly active and so can be used at low dosage rates. The first will control practically all soil insects, including ants, termites, grasshoppers, crickets and mole crickets. Used as a foliage spray, it will control many thrips, beetles and weevils. Aldrin has only a short residual life and where mealybugs are a problem it can be used on the affected foliage without seriously reducing the predator population.

Photo: Shell

Ants with coffee root mealy bugs (Neorhizoecus coffeae). *The helpless mealy bugs are taken from plant to plant by the ant attendants*

Dieldrin controls a wider range of pests, including some caterpillar species and fruit flies. It is also very effective against stem and fruit borers belonging to the beetle, weevil and fruit fly groups. Endrin is one of the most potent insecticides available today. It will control an extremely wide range of pests, including nearly all caterpillar and many aphid species. It is particularly useful where the pest complex is rather involved.

Shell International Chemical Co. Ltd. have produced a profusely illustrated brochure which summarises in a practical and readable form the methods of identification of soil insects, borers, foliage pests and deals particularly with the interesting ant/mealybug complex. It also describes the methods used for the control of soil nematodes and fungus diseases. Regarding coffee rust, *Hemileia vastatrix*, the classic disease, which is so destructive to much of the coffee in Africa, the Near East, South-East Asia and the Pacific, and which wiped out the coffee industry in Ceylon many years ago, it states that weekly and monthly sprayings with rather high dosages of Shell copper fungicide have been used to control the disease in Africa and India.

Polythene Tube Fittings

Hozelock Ltd. now manufacture and market patent couplings and fittings for all types of rubber and plastic hose and tube. This development follows the successful introduction last year of ingenious new plastic fittings for garden hose; the range of fittings has now been extended to cover many other uses, including farm water supplies and industrial uses.

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World Crop Reports

Increased Olive Oil Production Expected

INTERNATIONAL REPORT

Olive Oil

Production of olive oil in the Mediterranean Basin* is expected to reach 1,444,600 short tons this year, an increase of almost one-third above the 1,105,200 tons of 1958–59 and one-third more than the four-year average of 1,072,400 tons of 1954–58. This estimated production is second only to the record 1951–52 outturn of 1,512,000 tons.

Southern Europe, experiencing an 'on year' for production, is expected to produce 1.3 million short tons of olive oil in 1959–60, or almost 57% more than in the previous year. The most important increase will occur in *Spain* with its bumper crop forecast at 628,300 tons. The effects of the 1955–56 frost have now been dissipated and the important producing countries of Southern Europe are, as a result, now in line with respect to the biennial cycle of yield fluctuations. However, adverse weather kept *Italy* and *Portugal* from achieving the maximum potential for the 'on year'. *French* domestic output is at a low level, while *Yugoslavia* reports what would have been a total crop failure except for certain Adriatic islands.

The *Middle East* olive oil output is forecast at 68,500 short tons, a drop of more than one-third from the level of 1958–59, but almost one-fifth above the output for the last 'off year'.

A relatively good 'off year' crop is estimated for *Africa*, so continuing an upward trend in production. *Tunisia* has had the greatest decline of output, with a very low yield in the southern producing areas, but with progressively better yields between Sousse and Tunis to the north. *Libya* has recuperated this year from the severe drought conditions which reduced the 1958–59 output. Both *Algeria* and *Morocco* are expecting a good output for an 'off year'.

*More than 95% of the world's olive oil is produced in the Mediterranean Basin. The olive oil production and trade discussed cover all production from crushing, including non-commercial output, but not surplus or foots oil extracted from olive residue by solvent methods.

REGIONAL REPORTS

U.S.A.

Total *grain* production in 1959 matched the record of 1958, according to the U.S. Crop Reporting Board. The crop season was well above average for the nation as a whole, in spite of serious setbacks in some sections. Harvested acreage was slightly larger than last year, but yields per acre were generally below the records established in 1958.

Maize

The 1959 maize crop was estimated at a record 4,361 million bushels – 15% above the previous record in 1958 and more than a third above the 10-year average. The 85 million acreage was the highest since 1949, while the yield per acre of 51 bushels was near last year's peak. Maize matured in good time in most areas, but rain, snow, damp weather and soggy fields in October delayed the harvest and resulted in above-normal field losses due to broken stalks and ear droppage.

Wheat

Wheat production for 1959 is estimated at 1,128 million bushels – nearly a quarter less than the record crop of 1958, but 5% above average. Total acreage of wheat harvested for grain was 53 million acres, slightly less than 1958 and 13% below average.

The winter wheat crop of 923 million bushels was the fifth largest crop on record. Severe winter temperatures, lack of snow cover, drought and streak mosaic were mainly responsible for the 6-bushel drop in yield per acre from the 1958 record.

Spring wheat production totalled 205 million bushels – the smallest crop since 1954. The 28% decline from 1958 was entirely due to much lower yields, as growers harvested a 4% larger acreage. Durum production at 20 million bushels was much below average.

Oats

The 1959 oats crop of 1,074 million bushels was the smallest in 20 years and almost one-quarter less than in 1958. The yield of 37 bushels per acre was nearly 7 bushels below the record yield established last year, but still above the 10-year average.

Oats were harvested from the smallest acreage since 1892. This reduction in the heavy producing areas was mainly due to the removal of maize acreage allotments, unfavourable weather conditions at seeding time and the unusual prevalence of plant diseases and insects.

Barley

This year's barley production totalled 420 million bushels — 12% less than the record crop of 1958, but 32% above average. Production in California reached 68 million bushels. The Montana crop of 52 million bushels was about the same as last year, but more than twice the 10-year average.

Rye

Rye production was estimated at 21 million bushels – 10 million bushels less than last year's large crop and a million bushels below average. The sharp decrease in production was due to a smaller acreage and lower yields. Nearly three-quarters of the total crop reduction from 1958 occurred in North and South Dakota.

Grain sorghums

Production of grain sorghums was estimated at 579 million bushels for the third successive crop of over 500 million bushels. The 37.2 bushels yield exceeded last year's record and the 10-year average by 16 bushels. While grain sorghum acreage was nearly 7% below last year, the increased use of hybrid seed, favourable moisture supplies and the larger-than-usual acreage grown on irrigated land were mainly responsible for this record yield.

Soya beans

Soya bean production, estimated at 538 million bushels, declined about 7% from 1958 after five years of successive annual increases. The yield of

24 bushels per acre was the second highest on record, exceeded only by the top yield of 24.3 bushels per acre harvested in 1958.

Soya beans planted for all purposes in 1959 totalled 23 million acres or 7% below the acreage planted in 1958. Almost 96% of the acreage was harvested for beans.

Flaxseed

Production of 22 million bushels of flaxseed (*i.e.* linseed) in 1959 was more than a third below the previous year and the 10-year average. The yield per acre of 7.3 bushels equalled the second lowest yield since 1936 and was much below the near-record yield of 10 bushels per acre in 1958.

The reduction in planted acreage, plus heavy acreage abandonment, and low yields due to moisture deficiencies during the growing season, were mainly responsible for the poor out-turn in the Dakotas and Minnesota, where 88% of the crop was grown in 1959.

Cuba

Groundnut production has a high priority in the Cuban Government's programme to attain self-sufficiency in edible oils. Plantings in 1960 are expected to reach about 40,000 acres, with a potential harvest of around 14,000 short tons.

In 1959 an estimated 10,000 tons of groundnuts were produced from 30,000 acres, compared with 5,600 tons from 16,600 acres in 1958. The autumn crop of 1958 was almost a complete loss because of revolutionary activities in Oriente Province. Production and marketing conditions in 1959 were more nearly normal.

Groundnut production in the years ahead is expected to expand further – to possibly three or four times the 1959 output. Government financing is planned and a new agricultural co-operative in Pinar del Rio Province will be growing 565 acres of groundnuts this year. Cuba has two groundnut oil plants and a third is under construction: groundnut oil production in 1958 was about 1,000 tons, compared with total vegetable oil imports of 20,000 tons.

The 1959 *soya bean* crop – the country's first – is estimated at 17,000 bushels.

Cotton is about to become a commercial crop in Cuba. *Cottonseed* production from the 1959–60 crop is estimated at 3,800 tons. The seed will probably be crushed at the soya bean oil mill. A further expansion in production is expected in the future as part of the drive for self-sufficiency in cotton and edible oils.

Castor bean production is still largely experimental. One grower hopes to plant 1,660 acres this year if he can get financial assistance. Fungus is a serious production problem.

Western Nigeria

Land in Western Nigeria planted to *cocoa* now exceeds 1 million acres. The estimate, which represents an increase of 25,000 acres since the last census in 1952, came immediately after a Regional Marketing Board statement announcing a net trading surplus of £5,042,813 for the fiscal year 1957–58. The Board also announced that it had given £750,000 to the Ministry of Agriculture in Western Nigeria for agricultural extension work and cocoa research.

In a statement reviewing the cocoa industry, the Agricultural Ministry reported that a total of 119,145 farmers were trained to control cocoa disease so far this year, compared with 21,570 in 1958. Western Nigeria plans to distribute 8 million high-yielding cocoa seedlings to farmers during the current year and 10 million during 1960–61. This programme is part of the region's £165 million five-year development plan for 1960–65.

Rhodesias and Nyasaland

Cotton production in the Federation of Rhodesia and Nyasaland for this season (1959–60) is estimated at 11,000 bales (500 lb. gross). This is 15% below production of 13,000 bales last season, but 22% higher than the 1957–58 crop of 9,000 bales. In recent years cotton production in the Federation has fluctuated between 6,000 and 15,000 bales annually, depending on insect damage, weather and prices. Except for experimental irrigated plantings at the Gatooma Research Station in Southern Rhodesia, all cotton in the Federation is rain-grown.

Over 90% of the Federation's total cotton crop is grown in Nyasaland, mostly on individual small land holdings. Farmers sell their seed cotton to the Agricultural Production and Marketing Board, which operates markets throughout the territory.

Cotton production in Northern and Southern Rhodesia totals only around 1,000 bales annually. Although prices to producers are maintained at somewhat higher levels than in Nyasaland, insects and competition from other crops limit cotton expansion in these areas.

Japan

Japan's 1959 *rice* crop is estimated at a record 12,399,000 metric tons of brown rice (341,685,000 cwt. of rough rice). The record harvest is 14,000 tons (386,000 cwt.) more than the previous largest crop, in 1955, and 406,000 tons (11,188,000 cwt.) above 1958 production.

The higher yield than previously reported was due to north-east Japan's favourable weather in the maturing season. The final estimate of the 1959 crop may show a further increase because conditions for maturing rice after mid-October have been favourable in western Japan.

England and Wales

Mild weather at the beginning of January was followed during the first week by frost and fog. During the second week there were substantial snow falls over most of the country. A blizzard swept north-eastern districts on 19th, but by 21st a general thaw had set in and for the remainder of the month the weather was changeable, with heavy rain, particularly in western and south-western districts.

Conditions were not favourable for cultivations, although some progress was made during the early part of the month. On the whole, work was as forward as usual. Good progress was made in some areas with hedging, ditching and manure carting.

Wheat, on the whole, looked very well, although some damage due to waterlogging was reported from several areas. *Barley* was a good plant; *oats* were generally satisfactory. The small acreage of *rye* was healthy and vigorous. *Beans* were satisfactory.

Potatoes in clamps and stores kept fairly well, but rather more sprouting than usual was reported from some areas.

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